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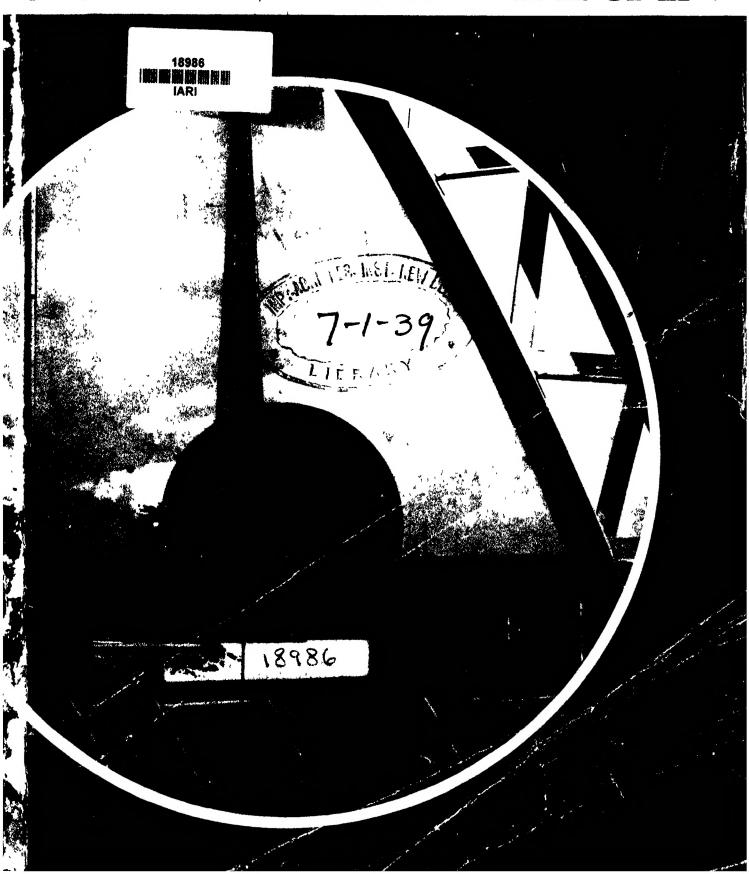
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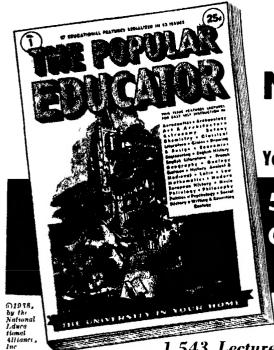
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NINETY-FIFTH YEAR

ORSON D. MUNN, Editor

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THROUGHOUT the New York World's Fair 1939 the keynote of building design will be symbolism, over-topped physically by the symbolism of the theme center—the Perisphere and Trylon. Our cover illustration shows these two unusual structures nearing completion; an article on page 24 of this issue tells of the problems that were met and solved in their design.

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50 Years Ago in



(Condensed From Issues of January, 1889)

PHONOGRAMS-"Subscribers to whom are rented machines can have left at their door every morning the waxy tablets known as phonograms, which can be wrapped about a cylinder and used in the phonograph. On these tablets will be impressed from the clear voice of a good talker a condensation of the best news of the day, which the subscribers can have talked back at them as they sit at their breakfast tables"

MANNLICHER-"Austria, like France, has adopted for the arm-

ing of her infantry a gun of small caliber, and has chosen the model presented by the armorer, Ferdinand Mannlicher This weapon, like the French gun (the Lebel), is of 8 mm. caliber, and fires a steel-incased ball The closing of the Mannlicher gun differs completely from that of guns provided with a bolt. The object of the inventor has been to suppress the lateral motion of the movable breech, and to effect the opening and clos-

ing of the gun by a single horizontal motion, such an arrangement permitting of exhausting the magazine of cartridges without removing the weapon from the shoulder. . To consider but the repeating mechanism, the Mannlicher gun may, as regards its simplicity, the strength of its parts, and its operation, be considered as the most perfect one that has been made up to the present

GAS-CARRIAGE-"At the exhibition of machinery which was held in Munich during the past year, the attention of the visitor was attracted to a vehicle with a motor constructed by the Rhine Gas Motor Works, Benz & Co., of Mannheim. This motor is driven by gas which it generates from benzine or analogous material . . . The motor . . . is placed in the rear of the three-wheeled carriage over the main axle . . , and the benzine used in its propulsion is carried in a closed copper receptacle secured under the seat, from which it passes drop by drop to the generator, and which holds enough benzine for a journey of about 75 miles. The gas mixture is ignited in a closed cylinder by means of an electric spark'

OIL-"Almost every vessel that encounters heavy seas reports, on reaching harbor, that oil was used in calming the waves with great success, and had it not been for the cleaginous liquid, the ship and all on board would certainly have gone to the bottom, Notwithstanding these multifarious statements, the percentage of vessels last appears to remain about the same. Even if the oil has no great effect on the angry waters, it certainly produces a powerful influence upon the imaginations of the mariners. They believe it adds to their safety, fears are allayed, good judgment is preserved, and all hands work intelligently,"

GAS-ELECTRIC LAMPS-"M. G. A. Tabourin proposes to the Paris Municipal Council to fit each lamp post with arc light, dynamo, and gas engine. He has contrived a dynamo of minute parts and a gas engine ten inches in diameter for coupling up with it, and would put a dynamo and gas engine in the post under each of the gas lamps, as used at present in that city, utilizing the gas supply for feeding the gas engine. . . Should his scheme prove practicable, we might be enabled to give up the discussion of burying wires, so far as high tension currents are concerned, for it would not require any.'

TORNADO--"A tornado which produced disastrous effects in many places on the night of January 9 visited a large region, including portions of New York, Pennsylvania, and New Jersey, and extending up to Canada. Among the more remarkable effects were the destruction of the Reading Silk Mills, in Reading, Pa., the

carrying away of the trusses and platform of the Niagara foot bridge, and the explosion of two gas holders in Brooklyn, N Y."

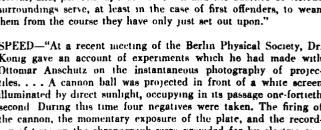
BIG GUNS-"On December 12 last, one of the 48-ton breech-loader guns of the French battle ship Admiral Duperre burst, whilfiring at a target off Toulon. An officer and five men were killed. This gun was one of the finest examples of the built-up system, of which many disastrous failures are on record. Those who brag so much about these guns, and are so ready to denounce cast guns, have considerable still to learn.'

(RIME-"The report of the Elmira Reformatory, now eight years in operation, will be

found worthy the attention of the scholar, as well as that of the humanitarian. It shows, so far as so limited an experience can be relied on, that the contamination of a penitentiary tends to encourage those to adopt carrers of crime who are not naturally vicious, and, per contra, that education and the absence of vicious surroundings serve, at least in the case of first offenders, to wean them from the course they have only just set out upon."

SPEED-"At a recent meeting of the Berlin Physical Society, Dr. Konig gave an account of experiments which he had made with Ottomar Anschutz on the instantaneous photography of projectiles. . . . A cannon ball was projected in front of a white screen illuminated by direct sunlight, occupying in its passage one-fortieth second During this time four negatives were taken. The firing of the cannon, the momentary exposure of the plate, and the recording of time on the chronograph were provided for by electric cur-

ELECTROCUTION-"The new law of the State of New York, ordering death by electricity as the punishment for capital offenses, went into effect January 1st."



AND NOW FOR THE FUTURE

(The hysteroid personality—always sidestepping trouble. By Paul Popenoe, Sc.D.

(Fire walking: Is this feat based on natural or supernatural phenomena? By Albert G. Ingalls.

(Soil testing and what it means to the gardener or farmer. By Arthur Hawthorne Carhart.

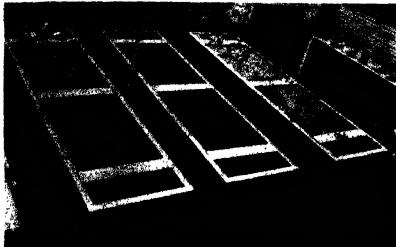
(From ashes to prominence: The Cinderella story of the development of the New York World's Fair site.

(Archeology reveals the ancient market place of Athens. By Prof. T. L. Shear.



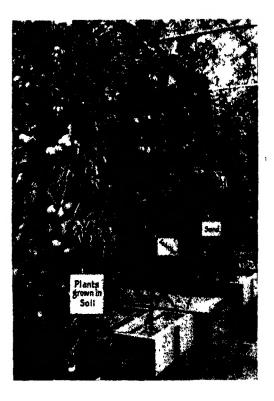
TWO BULLETS FROM THE SAME GUN?

I MAGES of two individual bullets, held in position under this comparison microscope's two objectives, are thrown together in the eyepiece. An "evidence" bullet is clamped under one objective and a test bullet, which has been fired from the suspected gun, under the other. Watching the two bullets in the eyepiece, the expert turns the thumb screws to rotate the bullets. If both were fired from the same gun, a point will be found where the rifling marks, or scratches, of one bullet will match those of the other. This instrument, shown reversed for mechanical reasons, is also used for checking the marks in the primers of two cartridges. It is a valuable adjunct to the work of the Technical Laboratory of the FBI, discussed in the article on page 22.



Courtesy California Agricultural Experiment Station

General arrangement of tank equipment and method of planting in nutrient solutions (above), showing the wire screen and the bedding "mattrese." At right: Tomato plants grown in fertile soil, nutrient solution, and pure sand irrigated daily with nutrient solution. Photograph shows plants, after seven weeks of constant harvesting, with excellent growth and large amounts of fruit in all three media. General cultural conditions—spacing, staking, and the like—were the same in soil, nutrient solution, and silica



Plants By Liquid Culture

of tank gardening, has attained the point where it fascinates and tantalizes the enthusiastic horticulturist, be he the merest amateur or the most advanced scientific research worker. Growing plants in liquid culture media is the adaptation by Dr. W. F. Gericke, of the University of California, of a century-old method for growing individual plants for physiological research. They may now be grown under this system commercially or for the entertainment and edification of the average home-owner.

Many terms have been suggested for the "new" method, such as tank or tray gardening, aquiculture, water culture, hydroponics, and so on. Hydroponics is the designation preferred by Dr. Gericke as it is more specific than others-"hydro" meaning water and "ponos" labor. It is not, however, a method which is going to revolutionize established agricultural or horticultural procedure. Neither is it going to upset the scheme of things so that every apartment dweller and home owner will be growing his own tomatoes and potatoes, or so that those more esthetically inclined will grow their favorite chrysanthemums, begonias, and the like, in the confines of their penthouses or rooms.

For those who are sincerely interested in the scientifically controlled production of plants, hydroponics offers a fas-

Fascinating Science for Amateur or Commercial Grower... Practical Details... Formulas, Specific Instructions, Suggestions... Window-sill Culture

By C. F. GREEVES-CARPENTER

cinating means of achieving their objective in a small space such as on a window-sill or where there is a lack of soil as would be the case in the limited confines of a roof. Experimenters, however, should know that there is little evidence that better plants or larger yields can be grown in water culture than under favorable soil conditions

THEN plants are grown in soil, they When plants are government from absorb their nourishment from many chemical compounds which are naturally present in the soil or have been added to it in the form of fertilizer. Water, acting on the introduced chemicals, releases the soluble food and makes it available for the plant 100ts. In hydroponics, no soil is present, the plant roots being immersed in water to which are added the requisite nutrient salts. There is, of course, an absorption of nutrients by the plants so that, under ordinary conditions, unless one is an analytical chemist and can determine which of the chemicals have been exhausted in the process of the growth of the plant, it is advisable to renew the entire solution frequently (for example, every two weeks) depending on the size and rate of growth of the plants. Changing the solution may be accomplished either by siphoning or by having a tight fitting spigot installed at the time the tank is constructed.

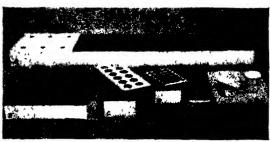
Tanks of wood, concrete, or black iron which have been coated with asphalt paint, make satisfactory containers. These may be of any length and width, but should be about six inches deep. For the sake of facility in figuring formulas, a tank two feet by six feet by six inches deep may be used satisfactorily for the initial experiments. This should first be filled with 25 gallons of water to find the water-level point. A mark should be cut into the side of the tank at this level, as it is most important that the solution not fall much below it.

A "mattress" of wire mesh—one inclifor the smaller plants but two inches if larger ones are to be set out—should be coated with asphalt paint. It should then be stretched on uprights so that it is

three inches above the surface of the solution as that distance will permit a certain amount of natural aeration. It is necessary, however, to supply some means of introducing additional aeration to the solution for this is an important factor in hydroponics. In the case of the small tanks mentioned, a bicycle pump inserted in the solution and worked vigorously for a few minutes twice daily will meet this requirement, according to Nathaniel Gould Harrold who has done much research work in hydroponics on a large scale.

ON top of the wire mattress should be spread a litter of straw or excelsior on which are placed pine shavings or other fine, inert material. The thickness of the actual bed of litter depends on what is to be grown in it. If seeds are to be broadcast on the surface, a depth of two inches is desirable, but where cuttings, seedlings, or bulbs are to be set out, a three- to four-inch depth offers a more solid bed for the plants.

When plants are first set out or seeds sown, the solution should have water added until it is brought up to within an inch of the bed. That this first solution has been diluted more than called for in the formula is not important. Once the white "water" roots have been formed, the solution should then be kept up to strength and three inches below the bed at the level indicated on the inside of the tank. If the plants set out in the litter are in an advanced stage of growth instead of being seedlings, the brown "earth" roots will die off when the new "water" roots are formed. All plants, seedlings, or more mature specimens, should have their roots pass-



Courtesy California Agricultural Experiment Station
Various types of containers for experiments by
the water culture method. They include several
sizes of iron tanks (not galvanized but asphalt
painted), a granite-ware pan, and Pyrex dish
and beaker for special small-scale experiments

ed down through the litter and wire mesh so that they are immersed in the nutrient solution.

When seeds are to be sown, the bed is first moistened with water, after which the seeds are broadcast on the surface of the litter and lightly covered. Cuttings or seedlings, on the other hand, are set out as they would be in soil. In transplanting seedlings, the soil in which they were started should be thoroughly soak-

THE new science of growing plants without soil (in nutrient solutions) has already been discussed widely, but very little more than generalities have been as yet presented to the public. After long effort, we secured the accompanying specifically detailed article; it gives full instructions and chemical formulas which will enable you to experiment in this fascinating science.

As a convenience to readers, we list below some of the companies from whom may be purchased the chemicals or ready-made nutrient mixtures for use in hydroponics.

Eimer and Amend Third Avenue & 18th St. New York, N. Y.

Nu-Way Products Co. 230 Fifth Avenue New York, N. Y.

John G. Davis 1915 Marin Avenue Berkeley, Calif.

The Hydroponic Co. Deadwood So. Dak. Ellis Laboratories, Inc. 98 Greenwood Avenue Montelair, N. J.

Garden Chemical Co. 241 Roosevelt Avenue Livingston, N. J.

University Apparatus Co. 2229 Magee Avenue Berkeley, California

Chemical Garden Co. 555 Asbury Avenue Evanston, Ill.

—The Editor.

ed to permit of their easy removal without injury to the roots. They should then be gently washed free of soil particles before being set out in the litter, at which time, as has been mentioned, their roots should reach through the bed into the nutrient solution. Bulbs are planted in the litter as though it were soil, and they will soon put on a healthy root growth if they are in good condition. At all times the litter should be kept moist but never saturated (waterlogged), for that would exclude air from the plants as well as create a tendency for unfavorable bacterial decomposition.

Of course, it is not possible to guarantee 100 percent success, and a lot of trial and error may be necessary before one finds the answer to the successful appli-

cation of hydroponics to his particular plants, locality, air, temperature, and humidity conditions. Such technicalities as the character (analysis) of the water, the adjustment of the chemicals in the nutrient formula to counteract undue alkalinity, and the like, will enter into the growing of plants by this technique. The pH value (the degree of acidity or alkalinity) of the water is a factor of the utmost importance in growing plants by hydroponics and this may be easily determined by the new-

ly developed litmus papers that have recently been introduced on the market. If the water is alkaline, either dilute sulfuric or nitric acid should be added to bring the reaction of the solution to pH 5 or 6, as shown by simple acidity determining kits. These reactions, pH 5 or 6, are only slightly acid, and the solution should be carefully held to about these points.

The next consideration is the choice

of nutrient salts. Many formulas have been packaged and sold through seed supply and mail order houses. Trials may be made with these to determine whether they are suitable for the particular plants it is desired to grow, as well as for the locality and other environmental conditions. If one wishes to try some of the standard formulas which have been developed by various scientists, there are several which have been successfully used by Dr. John M. Arthur of the Boyce Thompson Institute for Plant Research, Inc., at Yonkers, New York.

SOLUTION developed by Dr. J. W. A Shive which is easy to prepare and has been very successfully used is given in Formula I. Another, which was developed by Dr. Arthur and his associates at the Institute, is given in Formula II. This latter formula is used for growing many plants rather than for single specimens. Formula II is in ounces avorr dupois and is calculated for 25 gallons of solution, as is the Shives' Formula (1). Dr. Arthur has found it desirable to add traces of iron, boron, and manganese. Iron chloride, boric acid, and manganese chloride should be made up in saturated solutions and these solutions added to the formulas at the rate of ten drops of boron, five drops of manganese, and ten drops of iron to each 25 gallons of solution. Chemically pure salts need not be used in preparing the formulas as ordinary fertilizer salts will be found equally effective.

Prof. D. R. Hoagland and Dr. D. I. Arnon, of the Agricultural Experiment Station, College of Agriculture, University of California, suggest two formulas as being suitable for growing many kinds of plants. The "T.C." formula is given in Formula III, and the Station states that it "may often be preferred

because the ammonia salt delays the development of undesirable alkalinity." The ammonia and magnesium salts should be of technical grade, while the other two are fertilizer salts. The addition of the salts to the water should be made in the order given. To this formula should be added iron, boron, manganese, zinc, and copper. While copper and zinc are essential for plant growth, enough of these elements will usually be present as impurities in the nutrient salts or water so that the addition of copper or zinc can be safely omitted.

The boron and manganese solutions (also the copper and zinc solutions, if used) should be added in the recommended proportions each time the nutrient solution is changed.

POR the first of these five added chemicals, a level teaspoon of iron tartrate should be dissolved in a quart of water, and this should be added at the rate of a cupful to every 25 gallons of solution each week, or more frequently should the plants appear to be of poor color.

For the boron solution, a level teaspoon of boric acid should be dissolved in a gallon of water, and 1½ pints of this should be added to every 25 gallons of nutrient solution.

For the manganese solution, a similar quantity of crystalline chemically pure manganese chloride should be dissolved in a gallon of water. Prof. Hoagland and Dr. Arnon recommend the dilution of one part of this solution with two parts of water by volume and the addition of a pint of the diluted solution to each 25 gallons of nutrient solution

For the zinc solution, a like quantity of crystalline chemically pure zinc sulfate should be dissolved in a gallon of water, and four teaspoonfuls of this solution should be added to each 25 gallons of water.

For the copper solution, a teaspoonful of chemically pure copper sulfate should be dissolved in a gallon of water. This

should then be diluted at the rate of one part to four parts water, and one teaspoon of the diluted solution should be added to each 25 gallons of the nutrient solution.

Aside from the chemical elements derived from air and water, plants require at least eleven other elements. This is true, of course, whether the plants are grown under hydroponics or in soil. These chemicals, in the case of hydroponics, must be added to the water in proper form and concentration, so care must be exercised in this respect. In the natural process of growth, it will be found that certain plants require larger quantities of some chemicals than of others and it is also true that at certain stages in their growth they will absorb more of one chemical than of another. In order to avoid the tediousness of continual analyses of the solution, one practice is to empty the tank once every two weeks as has been mentioned, but, even so, water will have to be added in the interim to keep the solution at the desired level

When the tank has been drained for one of these semi-monthly changes, it should be half filled with 12½ gallons of water, then the nutrient chemicals should be added and the balance of the water should, when possible, be run in under pressure to insure an even distribution of the chemicals throughout the solution. The entire operation of draining and replenishing the tank should be done as quickly as possible to avoid any chance of the roots drying out

Soil-borne diseases are, naturally, non-existent in hydroponics, but insects, fungi, and bacteria are apt to be just as prevalent as in plants grown in soil. Mildew is likely to prove troublesome due to the humidity which is possibly increased by the moisture in the tank, but using dusting sulfur on the plants will keep this in check.

Temperature as well as strength and



When tall-growing plants are raised in nutrient solutions, firm supports must be fastened to the tanks

duration of daily sunlight are factors equally important whether plants are grown by hydroponics or in soil. Recent experiments in supplemental artificial lighting have been worked out by Lawrence C. Porter and his associates at the General Electric laboratories. These indicate that on cloudy days and during the winter days of shortened hours of sunlight, supplemental electric lighting is decidedly beneficial if applied for three hours every winter or cloudy day. A metal reflector should be bent so that the light beams are equally distributed over the tank area, and a 150-watt Mazda lamp will suffice as the light source. This should be suspended on a pulley above the tank so that it may be raised with the growth of the plants.

TOMATOES, potatoes, melons, beets, carrots, and other common plants respond very favorably to the controlled conditions which prevail under hydroponics. Roses, chrysanthemums, begonias, gladioli, and many other flowers may also be grown with marked satisfaction.

Hydroponics offers an intriguing field of investigation for the enthusiast. Once flowers or vegetables are successfully grown by this unique cultural technique, experiments may be made in attempts at controlling the flavor of vegetables or the color and odor of flowers, but with what success only individual research will show. Conditions are certainly more closely controlled than in soil, and with that as a starting point the investigator has much in his favor.

Formula I	
Monopotassium phosphate KH,PO,	7½ teaspoonful
Calcium nitrate Ca(NO _a) AH.O	20 "
Magnesium sulfate MgSO, 7H.O	121/2 "
Ammonium sulfate (NH,),SO,	21/2 "
Formula II	
Nitric acid HNO, concentrated (69.5 p.c.)	3.84 o
Transfer Title Title Company	
Ammonium hydroxide NHOH concentrated (5)	3.6 p.c.) sp. gr. 0.90 .88 o:
Ammonium hydroxide NHOH concentrated (58 Sulfurie acid H SO concentrated (95 p.c.)	
Sulfuric acid H.SO, concentrated (95 p.c.)	.67 o:
Sulfuric acid H ₂ SO ₄ concentrated (95 p.c.) Phosphoric acid H ₂ PO ₄ (90 p.c.)	.67 o: 1.29 o:
Sulfuric acid H ₂ SO ₄ concentrated (95 p.c.) Phosphoric acid H ₂ PO ₄ (90 p.c.) Potassium hydroxide KOH	.67 o: 1.29 o: .48 o:
Sulfuric acid H ₂ SO ₄ concentrated (95 p.c.) Phosphoric acid H ₂ PO ₄ (90 p.c.) Potassium hydroxide KOH Calcium oxide CaO	.67 o: 1.29 o: .48 o: .47 o:
Sulfuric acid H ₂ SO ₄ concentrated (95 p.c.) Phosphoric acid H ₂ PO ₄ (90 p.c.) Potassium hydroxide KOH Calcium oxide CaO Magnesium oxide MgO	.67 o: 1.29 o: .48 o:
Sulfuric acid H ₂ SO ₄ concentrated (95 p.c.) Phosphoric acid H ₂ PO ₄ (90 p.c.) Potassium hydroxide KOH Calcium oxide CaO Magnesium oxide MgO Formula III	.67 o: 1.29 o: .48 o: .47 o: .55 o:
Sulfuric acid H ₂ SO ₄ concentrated (95 p.c.) Phosphoric acid H ₂ PO ₄ (90 p.c.) Potassium hydroxide KOH Calcium oxide CaO Magnesium oxide MgO Formula III Ammonium phosphate (monobasic)	.67 o: 1.29 o: .48 o: .47 o: .55 o:
Sulfuric acid H ₂ SO ₄ concentrated (95 p.c.) Phosphoric acid H ₂ PO ₄ (90 p.c.) Potassium hydroxide KOH Calcium axide CaO Magnesium oxide MgO Formula III	.67 o: 1.29 o: .48 o: .47 o: .55 o:

Radium Hounds

Devices that Bay on the Trail of Lost Particles of a Dangerous Element... When a Pig Ate Radium... An Elephant Easier to Hide Than Stolen Radium

By ROBERT B. TAFT, M.D.

Author of "Radium-Lost and Found"

ADIUM is a gleaming sword in the treatment of disease, but it is a two-edged sword that has an unfortunate habit of getting lost. If the timest particle disappears, it is not only costly to replace (radium is worth 24,000 times its weight in pure gold) but also becomes an immediate menace to the lives of those who may unwittingly come in contact with its destructive rays. Actually, 107 cases of radium losses have been reported to me by members of the medical profession during the past few years. The potential danger lurking in a few milligrams of lost radium is so great that scientists have invented ingenious devices to recover it.

Radium is always handled in such minute quantities that occasional loss is inevitable. Thus, in treating cancer patients, doctors rarely use more than 100 milligrams—just about enough to cover the head of a pin. The amounts are so small that they must be mixed with other powdered salts and applied in tubes and needles made of extremely thin platinum or silver. On the cap of these tiny containers is an eyelet to which a piece of fine wire is fastened. The wire facilitates handling, but is only a partial insurance against loss.

Startling results in tracing lost radium are obtained by the use of some exceedingly clever devices known as "radium hounds." A rudimentary but effective "hound" is an electroscope consisting of a piece of gold-leaf with one end fastened to a metal support and the other hanging free. When electrically charged, the gold-leaf is repelled from the metal rod, and stands at right angles to it. Should the instrument be brought near a particle of radium, however, the electricity is partially discharged and the gold-leaf begins to drop. When the instrument is brought very close to the radium, the gold-leaf drops back to its normal position.

A tiny silver needle containing \$1000 worth of radium was salvaged at the Presbyterian Hospital in Newark, last year, by the use of this modern divining rod. The needle had accidentally fallen

into a pile of soiled dressings during the treatment of a cancer patient. Doctors discovered the loss only after the refuse had been thrown into the hospital inemerator. The silver container, of course, had by that time melted away; but since radium is virtually indestructible, even at terrific temperatures, hospital authorities knew that the missing supply was still intact somewhere in the roating blaze. When the furnace had cooled, the ashes were carefully removed in buckets and placed underneath the "radium hound" No response came until the 23rd bucketful was reached; at that point the gold-leaf fluttered--and dropped. In a few minutes the search was successfully completed.

THE moment a quantity of radium is reported missing, everyone concerned leaps into action. A hasty preliminary search of the laboratory may be made with a piece of willemite or an ordinary fluoroscope. Willemite is a fluorescent mineral which glows in the presence of radium rays. The fluoroscope reacts similarly, but neither method is effective except at very close range. If these fail, the more sensitive "hounds" must be commandeered.

Sometimes, when the gold-leaf electroscope is not sensitive enough, a device known as the Geiger-Muller counter is brought into play. This instrument consists of a tube connected at one end to batteries supplying an electric current; the other end leads to a system of vacuum-tube amplifiers. Radium rays, if present, reduce the resistance between the two ends; the electrical impulses thus set up are magnified to operate a loudspeaker. So sensitive is this instrument that 20 milligrams of radium can be detected at a distance of 135 feet.

While treating a patient in a Canadian hospital, a doctor lost a brass capsule containing 50 milligrams of the precious element. A preliminary check-up showed that the capsule was lodged somewhere in the city's sewage system. Engineers supplied the physician with a map of all drain pipes, most of which were more

than 15 feet below the street surface. Armed with a Geiger-Müller counter, the doctor then started from the hospital and slowly followed the path of the pipes as marked on his map. In the middle of the third block the clicks of the counter suddenly began to grow in volume and speed; and the trail grew warmer until the rapidity of the count told the physician that he was directly above the lost radium. A worker descended a nearby manhole and fished out the lost capsule.

In a Sioux Falls hospital a few years ago, a fantastic radium hunt began after a nurse momentarily placed a radium needle on the surgical table. The needle accidentally stuck to a piece of adhesive tape and was thrown away with a pile of refuse. By the time the loss was discovered, the rubbish had been carted off and dumped on a pig farm 40 miles away. Two University of Minnesota physicists were hurriedly dispatched to the farm. where they began testing endless piles of rubbish with their electroscopes. In the middle of their search, the gold-leaf began to quiver, but a moment later it resumed its normal position, despite the fact that the electroscope itself had not been moved. This recurred several times before one of the searchers noticed that the leaf quivered only when the herd of feeding swine nosed by. Acting on the unexpected clue, they divided the 500 pigs into groups and repeated the test until the leaf fluttered again. By the process of elimination, they finally reached one solitary pig. A butcher was called and the radium was recovered.

Uncanny as these detectors already are, technicians strive constantly to per fect their accuracy and sensitivity. A few years ago, the National Physical Labora tory in England devised an instrument called the "radium hen"—so named because the presence of radium makes the apparatus cluck just like a hen after it has laid an egg.

SCIENCE, which discovered radium, has developed virtually fool-proof means of safeguarding its use, and recovering it if lost. Sometimes radium is carried off by sewage pipes and lost in the ocean or rivers, where detection is nearly impossible. But in such cases, the radium has been deposited where it at least can do no harm. Apart from the financial loss, no one need worry.

Despite the fact that radium is worth \$25,000 a gram, with the present United States supply only 300 grams (roughly, 11 ounces) doctors seldom worry about loss because of theft. Disposal of the stolen product, for one thing, would be practically impossible. The market is confined almost exclusively to the medical world, and any irregular source could be immediately traced. A stolen elephant, moreover, would be easier to hide than a pin point of radium. The

(Please turn to page 47)

OUR POINT OF VIEW

It's On the Way

TELEVISION, problem-child of the laboratory, appears to be ready to turn the long-promised corner Announcement has been made that television (now called "video") programs will be presented on regular schedule by two or more eastern stations, beginning next spring. Congratulations to the earnest workers who have made great strides in this science—and particularly for their commendable reluctance prematurely to foist an imperfect service on the public. May the regular programs be as fine in quality as the admirable private demonstrations which we have recently seen!

Radio's Influence

FOLLOWING the recent "radio terror" broadcast, commentators and editorial writers did a pretty thorough job of plumbing the reasons for the public's unreasoning, instant credulity Largely, it was assigned to a juttery state of nerves brought on by the war crisis through which the world had just passed. Such criticism was levelled at the producers of the air-drama and such vociferous demands were made for broadcasters to censor themselves that it is hardly likely that such a dramatization with such possible consequences will be repeated.

Yet in all our wide reading about the unfortunate incident, we recall not one hint of certain broader implications Too much was said of war psychosis and nothing of the normal human equation We had thought that the Brooklyn Bridge would find no "buyers" now, yet the confidence men who periodically "sold" that structure in the old days had a harder job than the broadcasters of H. G. Wells' drama, for the latter explained over and over what they were doing. It begins to look as though there must be something inherent in the radio, in the mystery of a voice coming from an unseen speaker through a gadget of wires and tubes, that inspires unquestioning confidence. Otherwise, despite the war psychosis explanation, why did not more people question this particular broadcast as did one man we know who did not hear the original announcement? When his family got excited, he told them: "Turn to other stations. If it's true that a great meteorite has fallen, all stations will be hysterical about it."

The lesson that seems to be taught here more dramatically under what might be called purely test conditions than ever before-is that a few words over the radio, dramatized just so, exert a powerful influence over millions of our people With a given set of conditions, a psychosis carefully built up by radicals. reformers, politicians, or "revolutionaries" of whatever stripe, it would appear that only a few suave promises, hysterical diatribes, or epithets hurled at this or that would set the people off. Perhaps the most important thing is for all who use the radio in any way to look in ward, clean their own houses, and try to do some honest thinking and honest talking If they do not, there may be a revolution among listeners-a revolution of the radio switch in a counter-clockwise direction until a click is heard -F, D, M.

Premature

PREQUENTLY during recent years this journal has been urged by some of its readers to conduct certain scientific investigations, chiefly of "dowsing," or water witching for underground water with the traditional forked hazel bough

What, from an editor's point of view, would provide more fun—not to name worthier considerations of science and usefulness—than temporarily to aban don hard sedentary work at a desk in the heart of a greatesty and take to the open fields to test the abilities of dowsers!

No adequate investigation of water witching ever has been made. True, Sir William Barrett and William Besterman, in their book "The Divining Rod," report on numerous tests. Water is located, they finally conclude, by those who are endowed with a subconscious supernormal faculty, cryptesthesia. Unfortunately, the book reads like the special pleading of advocates. It largely lacks objectivity. It leans, Science did not receive it favorably

To investigate dowsing, we have been urged, simply test dowsers in the field results count. But this scarcely seems necessary since there is no question that dowsers do locate water. So, however, do others, and there is the rub. To prove dowsing would require something different—something that would provide an entirely undebatable answer. For this the human factor—the hands holding the forked bough and the brain behind the hands—would have to be eliminated. Science asks for pointer readings on unsentient apparatus. Apparatus has no motives. It does not even fool itself.

Just how would such apparatus be designed? On exactly what working principle? We doubt whether anyone knows (some appear to think they do, and bring

up such terms as "magnetism," "attraction"—unexplained in themselves). Until a working principle behind dowsing 14 found (if there is one) science is unable to proceed. An investigation would be fun but that is all it would be.—

A G I

How Much?

HOW much will it cost?" is a question that has wrecked many a promising piece of projected research Here should be a common meeting ground where science and industry see eye to eye in their efforts toward technological progress, yet all too often it is the stumbling point where progress is halted. It is the exceptional case where a research worker can say definitely just how long a certain project will take to complete or what his expenditures will be before he reaches his goal Even the goal is often indefinite and frequently changes as work progresses Research can in no way be compared with industrial production.

If industry is to realize the greatest benefits from the work of the pure scientist—who, indeed, is the dominant though retiring figure of present-day industry—he must be freed from the fetters of financial limitations, must be permitted to pursue his studies and experiments with a minimum of interference. By permitting such a course, the farsighted industrialist will find that his research laboratory will pay big dividends, often in a way that was unthought of when the work was started.

Charles F. Kettering, probably the best known research worker in the nation, recently uttered a plea for a better understanding between those who pay the bills and those who delve into the secrets of nature. Realizing that costs must be met, records must be kept, he suggested that industry in general apply the actuarial type of accounting to research, rather than cost accounting. Thus the costs of research would be allocated by a statistical average taken over a number of years and over a number of research problems

As industry gains a greater appreciation of pure science research and its effect on the applied science that results in new products, expanded markets, and better business conditions, costs of research will assume a less important place in the scheme of things and the laboratory worker will be encouraged to pry into many corners of which little is known, unhampered by the specter of dollars and cents.—A. P. P.

THE CONQUEST OF THE

Palestine's Biblical Lake, Containing Sufficient Potash and Other Chemicals to Supply the World for 2000 Years, is Now Being Actively Exploited

THE successful completion of extensive works upon the southern shores of the Dead Sea, in Palestine, for the recovery of potash and other valuable salts, similar to, but on a much larger scale than, the works established at its northern end a few years ago, calls attention to what has been done in winning these prized salts from the brineladen waters of this remarkable inland lake. Hitherto, potash has been obtained chiefly from Germany and France; more recently from the United States and Spain.

Until quite recently most people looked upon this hot, barren, and isolated region of the Dead Sea as of little value commercially. True, the waters were known to be impregnated with valuable salts, such as potash, bromine, and magnesium chloride, but the problem was to recover them on a commercial scale To extract these coveted salts called for considerable pioneer and experimental work extending over many years. It was necessary to ascertain the exact salt content of the waters and whether these salts could be recovered by solar evaporation. This called for years of patient study and research in a hot and desolate region many miles from any center of supplies, and these had to be brought in.

Potash is a white powder, and approximately 90 percent of the potash produced to-day is used as a fertilizer. It can be used in the natural state, or mixed with phosphates or nitrates. It also finds a place in the manufacture of explosives

Bromine is a dark, reddish brown, highly corrosive liquid, which is easily made volatile, giving off heavy vapors. It enters commerce largely in the form of its salts, of which sodium bromide, potassium bromide, and ammonium bromide are used in almost every civilized country. The principal outlet for bromine, however, is as ethylene dibromide, used with tetraethyl lead to form anti-knock compounds (that is, Ethyl fluid) which, when added to gasoline, assure smooth running in high-compression automobile engines used in most modern cars.

The Dead Sea, a great storehouse of valuable chemicals—a veritable Eldorado—forms part of a depression, a rift, in the earth's surface. The rift extends much farther than the boundaries of Palestine, running down the Jordan Valley and the Dead Sea to the Gulf of Akaba and, crossing to the African continent, reaching the great lakes in Central Africa. In the neighborhood of the Dead Sea this depression reaches its greatest depth, the surface of the Dead Sea being 1290 feet below the level of the Mediterranean. It is the lowest lying body of water on the face of the globe.

THE region of the Dead Sea is weird yet awe-inspiring, with its mountains of rock salt, its picturesque gorges, its caves, quaint little oases, and hot springs. There are the hot baths of Kalirrhoe where Herod came, when stricken with his last sickness, in the hope of finding that recovery which he sought in vain. On both the western and eastern side the Dead Sea is hemmed in by towering barren mountains, with scarcely any shore line. Everywhere there is evidence of great volcanic disturbances in past ages. No doubt the presence of sulfur, bitumen, and possibly oil, played their part in

causing the overthrow of Sodom and Gomorrah and the other cities of the plain. Where Sodom and Gomorrah stood no one really knows. Ruins of a lost city have been found at the north-western corner of the Sea, and some scholars believe they mark the site of either Sodom or Gomorrah. Others place the site of these cities at the southern end. The name of Sodom has, at any rate, been given to the new potash camp at that end. On the north-western side of the Sea rises Mount Nebo, from which Moses viewed the Promised Land.

The Dead Sea has a length of about 50 miles, an average breadth of nine miles, and a maximum depth of 1300 feet. It is estimated that, from the River Jordan and the other smaller streams, there pours into the Dead Sea on an average over 280,000,000 cubic feet of water daily.

As the Sea has no outlet, this water is entirely dispersed by solar evaporation—evidence of the great heat of the region. The waters of this strange lake are so salt and bitter that no fish can live in them, and their specific gravity is so high that it is impossible for a human body to sink. That is not to say that a person could not drown in the Dead Sea. Whereas in the oceans the percentage of mineral salts is but 3½, in the Dead Sea it reaches no less than 25 percent. Place a fresh egg in the water and it will float away like a cork.

When the potash company started operations at the northern end of the Sea,





Dead Sea

By HAROLD G. SHEPSTONE, F.R.G.S.

they required the whole of the area there for their works. This was the spot visited by tourists from Jerusalem. So a small area at the north-eastern corner of the Sea was set apart as a tourist rendezvous known as Kallia. It developed into a thriving resort, with restaurants, cafes, bathing and boating facilities and with a fleet of motor coaches carrying visitors to and from Jerusalem some 25 miles distant by road.

A popular time to visit Kallia is at full moon, when the writer has counted as many as 200 bathers in the water at one time. During one of the writer's visits to Kallia a young woman was drowned within a few feet of the shore and within

of the lake. Laying out these works, with their model settlement where some 500 Jews and Arabs with their wives and families dwell, was no light undertaking. Roads had to be built to the site, and a power-house, pumping station, refinery, and workshop erected. The desolate Dead Sea region suddenly became a place of great activity.

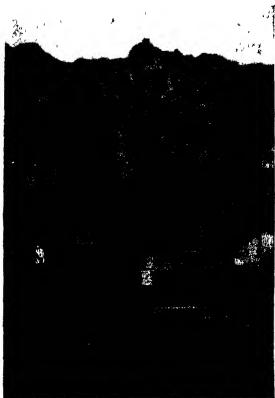
For two miles along the shore, and running back on either side of the River Jordan, are the evaporating pans, each from 7½ to 30 acres in



A sluice gate between the pans, by means of which the level of the flow of the brine is regulated. Note the incrustations of mineral salts on the timber work

her own depth. Apparently she had stumbled when entering the water, and was no doubt rendered partially unconscious through the pain set up by the water reaching the eyes. Her body did not sink, but her head, the heaviest portion, was under water. At Kallia no diving is allowed and bathers are warned not to get the water into their eyes. The workers at the potash plants are not allowed to stay in the water more than a quarter hour at a time unless there are facilities for a douche in fresh water.

As a result of the experiments carried out by Mr. M. A. Novomeysky, the managing director of Palestine Potash, Ltd., a complete plant for the recovery of potask was first erected on the northern shore extent, covering a total of more than 1200 acres. The brine is pumped into these pans by a great suction pipe laid on the bottom of the Sea and extending outward to reach a depth of 175 feet. Soundings showed that at this depth the water contains twice as much potash and bromine as on the surface. The pipe is 2500 feet long, 30 inches in diameter, and laying it proved to be no small feat. After sections of the pipe had been welded together on the bank, six days were epent in launching it, due to unfavorable weather and other causes. It was necessary to send down a diver to bolt the sections together. The Syrian diver employed found it impossible to work in the brine-saturated waters and an experi-



Jebel Usdum's cliffs of salt towering up just behind the camp established at the newer and larger plant at the southern end of the Dead Sea. Atop the salt hill is 1 lookout post in which are guards who watch for Arab attackers

enced diver had to be brought out from England. On the other hand, at the newly established works at the southern end of the Sea, the water is being pumped from the surface, as here it was not found necessary to lay a pipe to any particular depth.

At both the northern and southern plants the brine is pumped into the farthest and highest of the pans, which are so arranged as to allow a constant slow movement of the brine from one pan to another, in a zigzag, downward flow toward the Dead Sea. The pans are provided with sluices, permitting regulation of the flow or temporary shutting off of any of the pans when needed. In the course of such a tardy flow, the brine becomes more and more concentrated. Common salt is the first salt to be deposited in the pans. On further concentration carnallite, or crude potash, separates out.

The carnallite is harvested mechanically as soon as three to four inches have been deposited. It is then conveyed to the field mixers in the refinery, where it is decomposed with cold water and, on further treatment in the refinery, muriate of potash is produced to any de sired degree of purity. The brine left after carnallite separation—the "final brine"—contains the entire bromide in a concentrated form of magnesium bromide, which is conveyed by pumping to the bromine factory, where liquid bromine of a high degree of purity is ex-



Arab workmen on the carnallite fields, heaping up the carnallite near the railroad tracks in readiness for its removal. They are wearing high rubber boots to protect their skin against the harmful effects of the heavily concentrated mineral sults

tracted from the magnesium bromide.

Another portion of the final brine is left to concentrate further in pans till a specific gravity of 1.37 is reached. This occurs during the hottest part of the summer, when the thermometer touches as high as 160 degrees, Fahrenheit. At this point crystals of magnesium chloride separate out in the shape of long needles which are collected and further treated for the market. The remaining brine contains all the calcium chloride, which can also be extracted by a fairly simple method.

THE present output of the northern plant is 30,000 tons of potash and 1200 tons of bromine a year Since the flat land at the northern end of the Sea, suitable for building pans, is limited, the company acquired about 23 square miles of ground at the southern end of the lake, where, during the past three seasons, engineers have been busy, as already stated, building a power-house, pumping stations, refinery, warehouses, laying out the necessary evaporating pans, and establishing a camp for the workers

The settlement is at the base of Jebel Usdum, a mountain of rock salt six miles long and from one and one-half to two miles wide

The establishment of a model commercial plant and settlement in this hot and isolated region presented many problems. A whole season was spent in surveying the section. Then came the erection of a pier Everything had to be conveyed to the site by water from the northern end of the Sea. The transference of the necessary lumber, machinery, and stores was a formidable task in itself, for the local resources furnished nothing. At the end of two seasons' toil, however, the evaporating pans had been

built, brine was being pumped into them, and potash was being sent in specially-built barges to the northern end of the Sea for shipment to the world markets.

While it has been found necessary, owing to the great heat, to send the staff and workers at the southern end of the Sea away for a week's respite every fourth week during the summer months, the Dead Sea region can scarcely be described as unhealthy. The air is much warmer at the southern end of the lake than it is at the northern end, the thermometer rising in the summer months to as high as 160 degrees, Fahrenheit, at midday and seldom dropping to below 100 degrees during the night. Lying 1290 feet below sea level, there is more oxygen in the air-six percent morethan at normal sea level. There is an

entire absence of fog; the atmosphere is dry and the air clear. There are no mosquitoes or troublesome sand flies. As the salts obtained from the waters form the basis of many drugs used to combat and cure disease, it is thought that breathing the air that contains them in suspension is beneficial, while the waters are also highly radio-active, comparing favorably in this respect with the waters of those spas that are esteemed for their curative properties. These are the reasons given by scientists who have investigated the matter for the healthy condition of the toilers at the Dead Sea. Malaria and other diseases attributed to tropical conditions are unknown among them.

As already stated, it is believed that, with their southern plant working at full capacity, the company will be in a position vastly to increase the present output of potash, and other salts in proportion. British government experts who have made independent investigations declare that there are more than 1,000,000,000 tons of potash, over 800,-000,000 tons of bromine, and other salts in proportion, in this single sheet of water-sufficient to supply the world's present needs for the next 2000 years. Moreover, these valuable salts are continually being added to. They are steadily brought down by the Jordan in solution from the hot springs of Tiberias and also pour into the lake from the hot springs in the immediate neighborhood The Jordan alone pours into the Dead Sea about 40,000 tons of potassium chloride yearly.

WITH the exception of a single raw material—Diesel oil for generating electric power—all the raw materials used in the production of the potash and other valuable salts—that is, the waters of the Dead Sea, the sunlight, and fresh water from the Jordan or nearby wells—are available on the spot.



Potash being loaded into a 190-ton barge at the southern pier, immediately below Jebel Usdum, in preparation for towing to the northern end of the lake

More Than One Man's Fun

ALAMAZOO, Tacoma, and Washington, D. C., from which the photographs on this page originate, are but three American centers where clubs of amateur astronomers and telescope makers thrive today. There are similar clubs in at least three-score others. Ideally combining the scientific and mechanical urges with the pleasure of hobnobbing with fellow hobbyistsstudying astronomy, for example, in meetings, building telescopes together and thus throwing mutual light on each other's difficulties-these clubs of amateurs provide an outlet for what some believe to be a wish, perhaps unconscious, on the part of many, that they had chosen



Right: Tacoma
Amateur Astronomers with
home-made telescopes meeting
in Rainier National Park with amateurs from nearby
towns for a weekend of
observing

Below: National Capital Amateur Astronomers' Association, with 71 members (of whom 17 men and seven women made their own telescopes) meet near the National Observatory



Above: Kalamazoo Amateur Astronomical Association contains 36 members who own 21 telescopes made by themselves. A monthly meeting in some member's home permits observation; discussion and talks on astronomy or optics are given. A "night club" of this kind is less damaging to purses than another kind



a career in science when they were youths.

Persons of all vocations and ages are brought together by this common interest in astronomy and optics—though the actual telescope-making phase of these astronomical club activities seldom finds practical expression in youths less than 16 or 18 because it is work that requires more maturity, more general judgment and especially more patience and tenacity than most minors have developed. In fact, these same qualities, in the measure usually given an adult, rather than special skills beyond quite common "handyman" grade, are the main desideratum. The work is not easy—rather it is quite difficult—and this is the probable reason why it has made such strong appeal to persons of better than common intelligence. A department for the amateur "telescoptician" is published in every number of Scientific American.

THE IMAGE-SLICER

VERYONE realizes that the astronomer's Enemy No. 1 is cloudy weather; but the weather is his Enemy No. 2 as well. Often, especially in a climate like that of the eastern United States, the sky will be clear from horizon to horizon, and the stars brilliant on a dark background, and "snappy"—and the experienced observer takes one look at the violent twinkling even of stars in the zenith, shakes his head, and does not even bother to open up the observatory dome.

Sad experience has taught him that on such a night of "bad seeing" the image of a star will not come to any sharp focus. If he sets his eyepiece to the position which, on good nights, gives a sharp, clear image, he will see instead a large, fuzzy, and continually changing spot of light—shrinking perhaps for one good moment to something like a respectable star-image, and then exploding into a great flickering patch. Nothing has happened to the star, of course—the Earth's atmosphere is to blame.

WHEN the air is quiescent and steady, light passing through it is deviated by refraction, but by a fixed amount (depending upon the angle which the rays make with the vertical), so that the stars are clearly seen, but shifted in apparent position. Allowance for this shift demands more or less tiresome calculations, but can be fully made. But when the air is turbulentfull of streaks of different density-the rays from the star which enter different parts of the aperture of the telescope will be differently deviated. Each small bundle of them will come to a focus at a point corresponding to the direction in which it entered the instrument; but the combined effect of the whole will produce a blurred image, which will change continually as the wind carries different bodies of air across the line of sight. Windy nights are therefore unwelcome to the observer. Things are worst of all when the wind changes abruptly as the height above the ground increases. Where one layer of air slides over the other violent eddies are formed. The aviator flying through feels "bumps," and the astronome:, far below but trying to look through, gives up any precise work.

On an ordinary night the telescopic image will be fairly sharp, though blurred at times, and will dance about more or less. Observers are accustomed to describe the degree of steadiness by

A New Apparatus Used with the Spectroscope Cuts Star-Images into Sections, Rearranges these End to End, and Multiplies the Efficiency Very Greatly

By HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegic Institution of Washington

a scale of "seeing," ranging from zero on a bad night such as has been described to 5 on an ideally good one Such estimates are purely empirical, but by comparison of the figures assigned by different observers with the same telescope, or by the same observer with different telescopes, at the same place

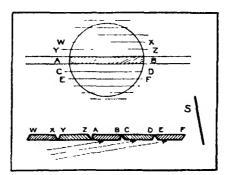


Figure 1: Showing diagrammatically the principle of the image-slicer, as redrawn from the author's sketch

and time, a fairly reliable scale can be derived.

A more open scale, running from zero to 10, has been suggested; but it has been said of someone that, being of a cautious temperament, he saved the designation 10 for conditions so ideally good that they never could actually happen, kept 9 for a situation so good that it never did happen, and called the very best nights "seeing 8."

When the seeing is bad, observations which demand the resolution of fine detail, such as measures of close double stars or study of the planets' surfaces, are impossible and most others are seriously disturbed. For example, if one seeks to photograph the faintest stars accessible with a great telescope—say the 100-inch-even moderately poor secing expands the images on the plate so that a longer exposure is necessary to get the faintest of them above the "threshold" of visibility. This wastes time. Moreover, if the exposure is long enough to produce fogging of the plate by the general background of the light of the

night sky (about half of which originates in the Earth's atmosphere) there is no gain in prolonging it further. The very faintest stars can therefore be photographed only on steady nights.

Bad seeing is also a serious enemy to the spectroscopist. To produce a sharply defined spectrum, in which lines closely adjacent in wavelength are separated, the light must enter the spectroscope through a narrow slit, only a few thousandths of an inch wide. The image of the star is thrown on this slit by the main telescope. The front surface of the slit-plate is polished, and reflects the light which does not enter the slit back to an appropriate guiding eyepiece so that the observer can see what is happening. If the seeing is very good, the star-image will be small-almost a point of light-and by careful use of the slowmotions of the telescope it can be kept upon the slit so that not much light slops over at the edges. But this happens only on the best nights. Usually the starimage is more or less fuzzy, overlaps the slit on both sides, and dances about faster than the guiding devices can follow it, so that a large part of the light is wasted. Under working conditions, 10 percent or even less may get through into the spectroscope.

To widen the slit lets in more light, but only at the expense of spoiling the sharp definition of the spectrum—which is, above all else, needful in many types of investigation.

To put a condensing lens in front of the slit, and make the star-image smaller, is possible; but this would make the angle of the cone of light which converges upon the slit greater. To get the whole of this wide angle beam, diverging behind the slit, upon the lenses and prisms (or mirrors and grating) of the spectroscope demands changes in its optical construction; and, when the effect of these is calculated, it is found that they just undo any gain which might otherwise be hoped for.

The problem of getting more light into

the slit, under given conditions of seeing, had been given up as hopeless; but it has just been attacked successfully, by a quite different method, by Professor I. S. Bowen, of the California Institute of Technology-widely known for his identification of the principal nebular lines a few years ago. His solution is simple in principle—though rather complicated to explain in detail. The spectroscope slit, crossing the middle of the (roughly) circular image of the star, cuts out a narrow slice from it, AB, Figure 1, upper drawing, and throws away the rest. Suppose that we could in some way cut out parallel slices of equal width, such as CD, EF, WX, YZ, and divert the corresponding light into other parts of the slit, arranged in tandem along its length, as illustrated in the lower part of the figure. We could then get all the light through the slit (barring the inevitable losses due to instrumental imperfections) and gain correspondingly.

The actual slicing of the image is accomplished with ingenious simplicity by means of a system of small mirrors, each set up above a part of the slit, such as AB or EF, and with its reflecting surface inclined at an angle of 45 degrees so that a beam of light traveling parallel to the slit-plate, in the direction indicated by the arrows, would be reflected straight down into the slit.

SUPPOSE we could set up the spectroscope itself with its axis at right angles to the telescopic beam of light, so that the latter followed the direction of the arrows, and would form an image like that in the upper drawing upon a screen set up at right angles to it, as represented by S in the lower drawing (where the screen is supposed to stand at right angles to the plane of the paper). Each of the small mirrors would then automatically cut off a slice of this image, and reflect it into the slit (away from the reader), and the problem is solved.

In practice it would not be convenient to put the spectroscope in this position; but it is very easy to catch the telescopic beam (which in Figure 1, lower drawing, must be supposed to be coming downward at right angles to the page) upon a simple mirror which turns it sidewise in the direction of the arrows.

The tiny mirrors must be only about 1/30 of an inch long, and but a few thousandths of an inch wide. Such small surfaces, standing alone, could not be accurately enough figured and adjusted; but by making a series of larger blocks of glass of the proper shape and mounting them so that the end of each one projects just the proper number of thousandths of an inch beyond the one preceding, the arrangement may be practically realized. The detailed arrangement, by which each mirror-surface is fixed exactly in the right position, so

that it takes its own slice of the image without either overlap upon the next or waste space between, and other refinements of the adjustment, could hardly be explained without a precise scale drawing. Indeed, an inspection of the device itself (which the writer has had the privilege of seeing) can be satisfactorily made only with the more powerful type of hand-magnifier. Every adjustment of the tiny pieces must be correct

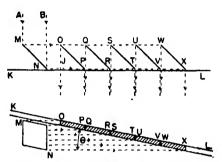


Figure 2: Drawings by Prof. Bowen, from a technical article in The Astrophysical Journal (Vol. 88, No. 2), plan below, elevation above. AB represents a cylinder of tays. Regarding these drawings Prof. Bowen there states: "In this diagram the beam of light is assumed to come from a lens of large focal ratio and, consequently, to approximate a cylinder of uniform crosssection, equal to that of the image, in the immediate neighborhood of the focus. This beam, bounded by the rays AM and BN, is intercepted just before it reaches its focus by the 45-degree mirror MN, which is placed near one end and slightly to the side of the spectrograph slit KL. This mirror is so adjusted that the reflected beam bounded by the 1ays MOQSUW and NPRTVX is parallel to the plane of the slit Jaws and just grazes their surface. The mirror MN 19 rotated about the initial direction of the beam (AM or BN) into such a position that the reflected beam crosses over the slit AL, making a small angle with it'

to a ten-thousandth of an inch, and the technical skill required for its construction is hardly less admirable than the ingenuity of its design.

When the star's light has thus been put through the slit there is more to do, for the effective source of the light entering the spectroscope makes up in length what it lacks in breadth, and has the same area as before. With no alteration in the optical system of the spectrograph, the spectrum formed upon the plate will be much wider than before. The spectral lines will be longer, but no more intense at any given point on their length, so that there would be little saving in exposure-time. This main purpose of the instrument is attained by placing a plano-convex cylindrical lens just in front of the plate. This lens runs lengthwise of the spectrum, and compresses the image greatly at right angles to the

dispersion, and so makes the lines much shorter and more intense, without affecting their relative positions at all. Here again much attention has been given to the details of design. The great spectrograph of the 100-inch telescope is fitted with a battery of Schmidt cameras, which bring the spectrum to a focus not on a flat plate but along a curved surface. To satisfy the conditions just described the "cylindrical" lens must follow this curve on its outer surface, and be like a portion of a cylinder which has been bent along its length into a circular arc. To make such an affair out of glass would be very troublesome and costly; but some of the new water-white plastics were found to be admirably adapted for the purpose.

It may be permissible to report that these preliminary tests of the "image-slicer" in actual operation show that under rather ordinary observing conditions the exposure time may actually be reduced to a quarter of that which would otherwise have been necessary. Further details should be left to be announced by the observers.

The larger the telescope, the more trouble it collects from the air. Hence the image-slicer will probably be even more valuable as an accessory to the 200-inch telescope than with any existing instrument. Îts usefulness is not confined to times of bad seeing For example, the image of a star low down in the sky is drawn out by refraction, no matter how good the seeing may be, and appears as a spectrum, with the red nearest the horizon, and the blue highest up. With an ordinary slit it is next to impossible to get the whole of this image in, and the observer must bear in mind what region of the spectrum he wants to get and guide on the colored image accordingly. But the image-slicer will take in the whole thing and solve this problem also.

FOR bodies which appear as luminous surfaces, such as nebulae, and perhaps a planet like Neptune, the new instrument will be of equal advantage. A great deal of work will still have to be done before its possibilities have been fully explored. But it is already evident that a major advance has been made in the detailed study of stellar spectra. With the new device, the 100-inch telescope should accomplish as much as the 200-inch could do without it.

It is particularly gratifying to record that this notable service to astronomy has been done by an investigator who has spent most of his time in problems of pure physics. It has been said, over and again, that co-operation between astronomers and workers in allied fields would be full of promise. This is a very fine instance of its successful results.—

Princeton University Observatory, November 5, 1938.

Everything Flows

NEW kind of scientist has come to the fore. He is studying almost everything that pertains to our existence, comfort, and enjoyment. He has gone so far as to give himself a new name—rheologist. As this word signifies, he is interested in the problem of the flow of materials. This subject has been studied intensively only in recent years.

We commonly think of gases and liquids as mobile and subject to flow, and of solids as rigid materials that do not deform, but before the critical eyes of the rheologist, everything flows! How rapidly the material deforms and how far depend upon the temperature and pressure to which it is subjected. The following examples and discussions of the flow occurring in stones, petroleum products, rubber, synthetic resins, and paint, suggest only a few of the rheological problems that are encountered in the preparation and use of materials with which we are familiar.

Traveling through the mountains and hills one becomes aware of the deformations that occurred in the rocks during the stupendous movements which took place in past ages. One sees places where molten rock has poured into fissures in colder stone. Rivers of lava have picked up bits of cooler rock and carried them along like twigs. The heat from the molten stone gradually softened the floating fragments, resulting in their elongation in the direction of flow.

Stones may also flow at atmospheric temperatures Such a phenomenon is well illustrated by a tombstone located in Rock Creek Cemetery at Washington, Industry is Finding Many Practical Applications of Science's Studies of the Flow Phenomena of Apparently Solid Matter as Well as of the Liquids

By R. N. TRAXLER, Ph.D.

D. C. This stone, which was mentioned in Scientific American many years ago (Feb. 21, 1903) was placed in a horizontal position in 1853 and originally supported by four short columns located at the corners During the 86 years that have elapsed since it was put in place, the marble slab has sagged without cracking, flow presumably occurred along the cleavage lines of the crystals of calcoum carbonate composing the stone. The kind of deformation undergone by this stone is known as plastic flow and is distinguished by the fact that a definite amount of force, characteristic of the particular material, is necessary to initiate the movement. After this force or yield stress has been exceeded, the material flows like a simple liquid. In the case of the tombstone the weight of the marble, supported only at the corners, was sufficient to start the deformation and maintain it at a very slow rate until the caretaker inserted a fifth column at the center of the slab and arrested the movement

Professor E. C. Bingham has called attention to other examples of the molecular flow or slippage along crystal planes in stone at atmospheric temperature and under moderate pressures. In the white marble veneering on the facade of St. Mark's Cathedral in Ven ice, the stone after centuries bulges out to the extent of several inches over a distance of about six feet without showing the presence of any cracks or fractures. He also states that at the Palace of the Alhambra, in Granada, Spain, one of the two doors which has been christened "La Mezquita" exhibits an ancient facing of three slabs of marble The building has subsided, causing a considerable thrust upon the marble facing but the stone, "instead of break ing or of rupturing its casings, has simply bent and curved as if it were wood."

'N the great petroleum industry flow 1 is a subject of paramount practical importance. Removal of crude oil from the earth, its frequent transportation to the refinery through hundreds of miles of pipe, its passage through the involved processes that create a multitude of useful products, and finally most of the uses and applications of petroleum products, present unusual and interesting problems to the rheologist. The ideal lubricant for your auto or airplane motor should be sufficiently mobile at low temperatures to lubricate and protect the moving parts of a cold engine without becoming so thin and fluid at elevated temperatures as to lose all usefulness as a protection for the moving parts of the engine. Present-day lubricants are being tailored to fit the specifications laid down by the rheologist. The flow characteristics of heavy oils and greases change with temperature. As the molecular activity of such materials is reduced by decreasing temperature they often cease behaving like water and other simple liquids and become plastic in nature. This complication of the flow characteristics is due probably to the development of an internal structure through orientation or arrangement of the molecules present. These orientations are definite enough to result in alterations of the way in which the material is deformed by an applied force but in most cases do not proceed to the point of causing the appearance of crystals.

The sagging James Martin tombstone in Rock Creek Cemetery, Washington, D. C. The string and cigarette case show the extent of the sag caused by the flow of the stone (The notch in center of stone is due to rain water ecosion and is not, as it may seem, a crack or break.)

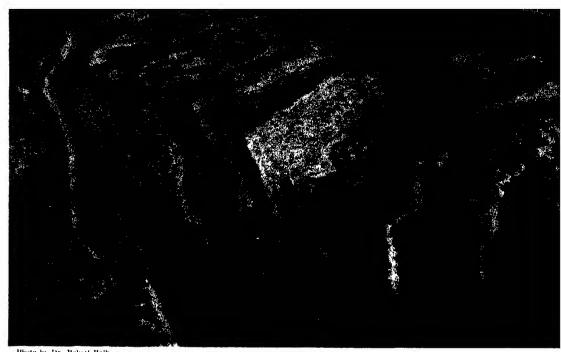


The low temperatures at which these unusual and anomalous flow characteristics appear are frequently encountered during the winter months. Any alteration in the structure of the oil or grease which removes those properties detrimental to its lubricating value offers substantial economic return to the user, because of greater protection to his machines.

Asphalt, which is obtained from the distillation of certain kinds of petroleum or is dug from naturallyoccurring deposits, is used in many places because of its unique rheological properties Recently, engineers of the Mississippi River Commission tried a new type of revetment for the protection of the river levees

above New Orleans A mattress conposed of asphalt, mineral dust, and sand, and containing wire reinforcement, was prepared on a barge from which it was fed into the water over a large roller. One end of the blanket was fastened to the inside of the levee but above the normal flood water line, the other extending to the bed of the river Thus, the inner surface of the levee and a portion of the bed of the river is covered with a flexible, clastic blanket which resists the scouring, crosive action of the strong currents of soil-laden river water Sudden shocks will not rupture this type of mattress because of the strength imparted by the reinforcement and the clasticity of the asphaltic mixture. An elastic material will deform under an applied force but returns to its original position after removal of that force.

A QUARTER of a century ago an auto tire gave 3000 to 5000 miles of service. Now we like to boast of the 20,000 or even 30,000 miles we have driven at high speeds on a particular set of tires. In order to bring about this improvement the rubber is blended or compounded with various chemicals that confer greater mechanical strength combined with the retention of flexibility and elasticity for long periods of time The rubber is worked and kneaded between great rollers. During this calendering considerable heat is developed, the added ingredients are thoroughly dispersed, and the flow properties of the rubber are greatly altered. It has been discovered that the properties of a sheet of calendered, plasticized rubber are different in the direction of calendering than at right angles to that direction. This unique behavior has been taken as an indication of the presence and orientation of long molecules or aggregates of molecules known as micelles.



An example of flow folding in marble. This stone was not in a molten condition when it folded into the sinuous shapes shown here. Pressure and, especially, time are quite well able to account for this result

Various theories have been proposed to account for the great elasticity of rubber. One interesting view is that in any highly clastic material the molecules or groups of them are arranged much like a mass of coiled wire springs. A push or pull on the material compresses or extends these long molecules or molecular aggregates and when the applied force is removed the "coils" return to essentially their original position. The elastic properties of rubber can be reduced or destroyed by heat or excessive working, and may be lost if the material is maintained in a stretched condition for a long period of time. This last phenomenon is illustrated by the behavior of a rubber band which is left undisturbed about a bundle of papers for a considerable time. The rubber no longer possesses either elasticity or mechanical strength, the little coils appear to have become brittle and to have lost their ability to return to their original posi-

Since the day that Dr. Backland perfected the first commercially useful synthetic resin from formaldehyde and phenol (carbolic acid) the applications of these materials in our complicated, industrialized civilization have become too numerous to list. Drinking cups, ash trays, telephones, dental plates, beautifully colored walls and cabinets, are a few examples of the many useful articles formed from synthetic resins, called by one theologist "organic glasses." The desired object is fabricated by placing a powdered resin mixture in a hot mold and applying pressure. Under such conditions the resin particles melt together and flow into a single mass which takes the form of the mold. During the molding operation the nature and properties of the material may or may not

thetic resin in use today, which are differentiated by their rheological characteristics: the kind that takes a permanent set during the molding operation and cannot be softened again at elevated temperatures, and the so-called thermoplastics that are rigid at ordinary temperatures but soften as the temperature is raised

ONTROL of the consistency (re-Sistance to flow) of the synthetic resins during their formation is very important. The reactions between the constituent raw materials, which are usually considered to be polymerizations and condensations (intermolecular combinations which will continue indefinitely unless halted by a drop in temperature or by chemical means), must be stopped at the proper point if the finished article is to possess satisfactory properties. Great ingenuity has been displayed in devising instruments for measuring rapidly and accurately the progress of these reactions as indicated by the changes in the fluidity of the product. The flow properties of the finished resins vary from the characteristics of simple fluids to those of plastics possessing distinct elastic effects. Elasticity becomes the dominant property in the synthetic rubbers In discussing these substances one authority has said ". . . and perhaps in many cases it is only a question of definition whether a substance must be considered as a resin or as a rubber." It is interesting that some kinds of resins show great flexibility (a bar or sheet of them can be bent around a sharp edge without cracking) but do not possess the ability to snap back into position after being deformed. The materials showing these unique and useful properties have been considered by certain investigators as existing in a gel (jelly-like) state, In general, there are two types of synthe lattice-work structure containing a

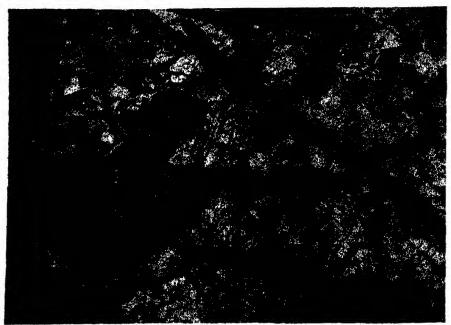


Photo by Dr. Robert Balk
Flow in molten rock. The black mass at the left, and radiating lines, are obsidian
(volcanic glass) which flowed into cracks formed in the lighter-colored stone

relatively high content of a very viscous liquid, which prevents an elastic return after deformation.

When a finely divided solid is suspended or dispersed in a liquid the mixture frequently possesses unusual rheological properties. House paints are excellent examples of such mixtures. The same distinctive flow properties frequently appear when a liquid (for example, an oil) is dispersed in another liquid (water, for example) with which it is not miscible. Mayonnaise is such a suspension or emulsion. Even a catalogue of the present-day applications of dispersions, suspensions and emulsions, ranging as it would through cosmetics, foods, drugs, dyes, leather and photography, would require considerable space. The suitability and usefulness of these materials for their intended purpose depend to a great extent upon their flow characteristics, and consequently in recent years a vast amount of research has gone into the development of new methods of measuring the various rheological properties. We are now beginning to understand how these properties are affected by different variables: the particle size, size distribution, shape, and amount of the dispersed material present have been found to have a profound influence on the characteristics of the mixtures Of course the viscosity of the liquid employed is important and in certain cases chemical reactions occurring between the dispersed material and the suspending liquid also have a pronounced effect. Since these chemical reactions can occur only at the surface of the dispersed material, their effects will be most apparent when the particles or droplets are small (thus presenting a large surface area per unit weight or volume).

Some heavy, slow-moving dispersions

or suspensions become fluid when they are stirred, again returning to their original high consistency after standing for some time. Such mixtures are said to be thixotropic. With the passage of time orientation of the particles probably occurs, producing a structure in the mass which can be destroyed, at least partially, by mechanical agitation. Then, when the agitation is stopped, orientation begins to develop again with consequent increased resistance to flow or deformation. Another explanation, but the reverse of the above, has also been proposed in order to explain the phenomenon of thixotropy. It has been suggested that at rest the rod- or needle-like particles are in an unoriented arrangement, like a log jam in a river. The interlocking of the dispersed particles accounts, for the resistance to flow shown by the mixture. When, however, the mixture is stirred the particles arrange themselves parallel to the direction of movement, like logs floating down a stream, and the mixture possesses greater fluidity. The difficulty with this explanation is that thixotropy also has been found to occur in suspensions of spherical bodies which cannot arrange themselves like logs They can, however, orient themselves to form a structural framework which can be broken down by mechanical agitation (stirring).

Many of the paints and lacquers in use years ago were difficult to apply because the brush marks would not disappear. Thanks to the rheologist, the objectionable property of poor brushability, which is chiefly due to the presence of thixotropy in the paint or lacquer, has been to a great extent eliminated. For many years little progress was made in devising new paints and protective coatings, or in improving those already

in use. Then, immediately following the World War, a new era in paint chemistry was ushered in by the appearance of the lacquers derived from a compound of cotton and nitric acid, and known as nitro-cellulose. The synthetic resins mentioned above have also been developed into very useful varnishes.

With the advent of the quick-drying cellulose and synthetic resin paints there appeared numerous problems for the student of flow. A finish which has been sprayed or brushed on a vertical surface must not flow under its own weight, but small irregularities and brush marks must disappear before the finish dries Such conditions demand a fine balance in the flow characteristics possessed by the paint. As an illustration of the success attending the work of the modern varnish chemist, is the fact that synthetic resin finishes are now used on airplanes and, although they are dry and hard in a few minutes, they present a perfectly smooth surface.

ANYONE who has walked on the wet sand of the beach has noted that often the moist sand suddenly becomes dry around his foot, but the sand immediately appears wet when the weight is removed. This phenomenon is known among rheologists as dilatancy and is dependent upon the almost unbelievable fact that pressure applied to a packed granular solid causes the mass to expand in volume, thus creating larger spaces between the particles. In the case of the beach sand the moisture on the surface which made the sand appear wet was drawn by the forces of capillarity into the larger interstices between the grains created when weight was applied to the packed granular mass. When the foot was raised the sand particles drew back together and the excess water was squeezed out of the smaller interstices between the grains and back to the surface. Dilatancy has an important bearing on the design of foundations, dams, or any structure composed of compacted granular materials. Incidentally, if the housewife wishes to get the maximum amount of ground coffee into a can she should not press it down but should shake or tap the filled container.

As we look into the future we can visualize rheology playing an increasingly greater part in the solution of the problems affecting man's comfort, convenience, and well-being. We see his transportation on sea, land, and air being made more comfortable and safe; we recognize the creation of more nourishing, attractive, and palatable foods; we find rheology marching side by side with the other sciences to fight a successful battle against diseases which have affected humanity since the beginning of our records. We see every human activity influenced by the work of the rheologist because—everything flows?

Mineral Waste Reduced*

DETTING something for nothing may be impossible, like perpetual motion, but industry manages year after year to get more without spending more. Forward-looking scientists and engineers still deplore the inefficient use of materials, mechanical energy, and man-power, but even a brief glance backward reveals that progress is being made, and quite rapidly.

Nowhere is waste more deplorable than in the production and use of minerals. Our supplies of mineral raw materials cannot be renewed; there is no possibility of getting a new crop. It took nature millions of years to segregate deposits that man can consume in a very short time. Few individual mines have an active life of more than a decade or two, and some of our useful minerals, provided we keep on consuming them at the present rate, may become as extinct as the dodo, for all practical purposes, within the brief span of one man's lifetime. Owing to the fast-increasing dependence of our civilization upon mincral raw materials, the idea that we are likely to rob future generations of their birthright commands the interest of government bureaus in conservation. Industry can scarcely be expected to take the same lofty interest in posterity-and it is debatable whether a miserly curtailment of useful consumption would be in the public interest even in the long run-but industry as well as Government has a stake in increasing the marginal utility of the minerals that it requires and in getting them more economically.

THAT better technology permits extracting more values from a given mineral deposit and thus enlarges our reserves of usable minerals is abundantly proved by the fact that waste dumps, tailings, and slag piles from the mining and treatment operations of fairly recent years are already being worked over, and sometimes re-worked again, as new methods make possible better commercial recoveries of the values. The implications of such developments upon the mining industries and upon the self-sufficiency of the Nation, however, are better revealed by reviewing the changes that have taken place during a definite period.

A quarter century ago, the Bureau of Mines published a thought-provoking little bulletin (No. 47), entitled "Notes



Froth flotation tests in the Bureau of Mines Laboratories. Research is continually under way in these laboratories to increase the recovered values of minerals

Conservation Progress . . . Agriculture, Industry Benefit . . . Miners Profit by Former Wastes . . . Greater National Security in Strategic Minerals

By PAUL M. TYLER

Chief Engineer, Nonmetal Economics Division, Bureau of Mines, Washington, D. C

on Mineral Wastes." In this bulletin, Dr. C. L. Parsons, the Bureau's chief chemist at the time, outlined certain opportunities for conserving mineral raw materials and, more important, expanding their economic utility. This summary affords a convenient backsight from which we can check up a few of the predictions then made and review the actual changes that have occurred during the intervening years.

Modern scientific agriculture is based upon the mineral industries in much the same way as the industrial and social accomplishments of the present-day machine age are predicated upon ample-supplies of mineral fuels and metals. A great number of chemical elements are requisite to the growth of the plants

that provide our foods and fibers, and three of them—phosphorus, nitrogen, and potassium—are exhausted from the soil so rapidly that they need to be replaced artificially and regularly through the medium of fertilizers.

In 1912, the United States—in fact, the entire world—had to go to Germany for its potash. To escape this complete dependence, efforts were being made to unlock potash from feldspar, leucite, alunite, and other rocks, and from seaweed. The fact had just been discovered that potash also was present in the brines of Searles Lake, California. All these sources were tapped during the World War emergency, but more prophetic yet was Doctor Parsons' remark, after describing the German

*Published by permission of the Director, U. S. Butesu of Mines.

deposits of soluble potash: "No like deposits are known in this country, although if a large number of widely separated bore holes could be sunk in selected areas it is by no means improbable that beds would be found." Many years later, the Bureau of Mines and Geological Survey undertook a drilling campaign and now we have found that virtually inexhaustible supplies of potash, some of it very high grade, extend in non-outcropping beds beneath a wide area in New Mexico and Texas, Commercial production began in 1931.

We still buy potash from abroad, much of it still from Germany, but new discoveries have been made in other countries, as in the United States, and no longer must we pay four times as much as it costs to lay it down on our shores. If we chose, we could promptly

produce more than we are likely to consume.

Nitrogen, needful for munitions and industrial purposes as well as for agriculture, likewise was supplied by a foreign monopoly. During the World War, a possible blockade of the ocean lanes to Chile, if long maintained, would have precipitated a crisis that might easily have turned the balance in favor of Germany, which had already developed the nucleus of an industry for capturing nitrogen from the air. Whereas in 1913, the world drew nearly 56 percent of its nitrogen from Chile, 37 percent from coal, and only 7 percent from the air; by 1934, almost 75 percent came from the air, and 18 percent from coal, while only 7 percent was furnished by Chilean sodium nitrate. Production grew, meanwhile, from 851,400 to 2,108,500 tons

THE third principal plant food, phosphorus, was plentiful in the United States even in 1912, but received attention at that time because Florida miners were throwing away two or three times as much as they saved These appalling losses now have been largely reduced; the introduction of flotation and the allied art of oiling-and-tabling doubled at one stroke the possible economic recovery from current production, permitted old tailing ponds to be re-worked profitably, and expanded the already large reserves of commercial phosphate rock.

Phosphorus is a vital element in animal and human nutrition as well as an important plant food. Unless we replace it in our heavily-cropped soils, not only will the nation be threatened with decreased crop yields and higher prices for foods and fibers but the health of our animals and even that of our people



The microscope assists the Bureau of Mines principal mineralogist in his identification of mineral specimens for the purpose of advising producers as to their commercial uses

may suffer tragic damage. Last spring concern over our supplies reached fever heat. However, a Congressional Committee appointed to investigate has been deluged with data that dispel doubts as to our huge reserves; the latest news smoked out by the investigation is the probable existence of billions of tons in bedrock beneath Florida land-pebble deposits—but that is another story

Sulfur is another mineral that was being exported a quarter century ago, since it was produced more cheaply in Louisiana and Texas than anywhere clse in the world; but we were also importing for its sulfur content nearly \$3,-000,000 worth of Spanish pyrite, mostly for making sulfuric acid for fertilizer manufacture Even then, about one fourth of our acid was made at copper and zinc smelters, but, in the far west, metallurgical stacks were belching out enough sulfur dioxide to make three times the quantity of acid then used in the entire country. Inasmuch as many of our smelting plants are in relatively sparsely settled regions, it is still more economical to make acid from sulfur or pyrite near the point of consumption; but significant progress can be recorded in salvaging the waste sulfur gases, largely through integrating and expanding the activities of the smelting works themselves.

The harmless disposal of noxious fumes has become more of a problem than it was 25 years ago, and unless the recovered acid can be utilized nearby for making some useful product that can be used locally or is valuable enough to stand the cost of shipping it elsewhere, the conversion of sulfur dioxide into sulfuric acid creates a worse nuisance than the gas itself. Now, however, the metallurgist has a new bag of tricks that

enables him to recover the sulfur in elemental form.

In the ceramic industries, great strides have been made in the substitution of domestic for foreign materials and in the betterment of materials. The adherence of potters to rule-of-thumb methods and their reluctance to try a new ingredient in their batch could not be dispelled so long as differences in the practical working properties of materials from different mines, especially clays, could not be explained convincingly by ceramic chemists. Some of these mysteries are being cleared up. The Bureau of Mines, in co-operation with other agencies, is working toward the duplication of the highest-grade kaolins by beneficiating (or processing) relatively impure clays. Improved technique, including the application of froth flotation, affords the means for fractionating and re-combining these components in uniform and reproducible proportions. A potter who hitherto dared use only a kaolin from a single locality in Czechoslovakia or a designated brand of Cornish ball clay can soon obtain a synthetic clay that will not only work the same way but may be more uniform in quality.

THROUGHOUT the gamut of ceramic industries—porcelain, enamels, stoneware, tile, glass, refractory products, and even common brick—the touch of science and the insistence upon everbetter products has called for better and better raw materials; this demand has been met not by exotic materials from far-away lands but by beneficiating those that lie at our own back door.

In addition to its use in pottery, highgrade clay is employed even more extensively in paper and increasingly also in rubber and other industries. American clays formerly were deemed unfit for such purposes but now, thanks to proper preparation at the mines, are often preferred and generally are used instead of foreign clays except in a few localities where the hard facts of geography coupled with the advantages of water-borne transport make them over ly expensive. That such processing pays is indicated by the fact that a certain domestic clay sells as high as \$60 a ton, displacing not only imported clays but also costly satin white for coating the finest paper. Bleaching clays are now exported from the United States in fairly large quantities, whereas in 1912. despite a duty, imports of English fullers' earth were increasing steadily

Typical of former waste products for which new uses have been found is aisonic. Formerly 25,000 tons a year of this poisonous element were discharged

where it is mined for its own sake and not as a by-product. Leading its many uses is the surfacing of roll roofing, now grown into a large industry indeed; present signs portend plainly a tremendous expansion in consumption of ground mica in the paint industry. Long ago we exhausted the current supply of waste from mica mining and factory scrap, and after absorbing by-product flake from clay washing, we have taken to mining schists to augment our supplies of ground mica.

Chemical plants that once worried over getting rid of their calcium chloride are now able to sell all they can make Widely used for dust laying, it is increasingly employed in the construction of stabilized roads, ice control on highways and sidewalks, dust-proofing coal and other materials, refrigeration, and sundry other industrial uses.

New uses for bromine were sought



Developing a practical separation of numerals in a magnetic machine. Such research has resulted in large gains in conservation of our numeral resources

into the atmosphere by the copper and lead smelting plants of the United States, but most of this wastage has been stopped By cooling the stack gases, the arsenic fumes can be caught in bag houses or precipitated electrically. Now we use annually 35,000 tons of white arsenic, which has become one of our chief weapons in the far-flung warfare against insects and weeds. Over one half of this arsenic is imported from other countries in which it likewise is a byproduct and consequently can be recovered so cheaply that costs of transportation largely determine the price.

The utilization of so-called mica "waste" has progressed to the point

eagerly for many years, but after it came to be used in the production of Ethyl gasoline, supplies from by-product sources became so hopelessly inadequate that the Ethyl-Dow Chemical Company in 1934 began pumping raw sea-water in ever-increasing quantities simply to extract the bromine.

Bromine's sister element iodine, although seemingly destined always to be a Chilean monopoly, by virtue of its association with natural nitrates, likewise has altered its status during the quarter century under review. Research developed American supplies and means of recovering it from oil-well waste waters in California. We still import the element

from Chile but the price has tumbled from \$4 to 81 cents a pound.

Natural graphite continues to be imported, thwarting several attempts to draw economically upon our large domestic reserves, but to offset this we are substituting manufactured graphite, artificially made from anthracite or coke, for important uses; and by modifying out foundry and fine steel making practices, we no longer depend upon certain qualities of foreign graphite that formerly were deemed essential. During the World War, we were tremendously concerned as to our ability to bring graphite halfway around the world from Ceylon and Madagascar to supply our munitions plants, but graphite has ceased to be listed among the strategic minerals

Fluorspar, barrie, and asbestos are industrial minerals that we keep on importing in substantial amounts, but by progressively reducing mining waste and perfecting methods of treatment, our dependence upon foreign supplies has become less and less

A^{MONG} non-metallic mineral products, probably none has made more substantial progress than Portland cement, the annual production of which doubled some years ago its 80 million barrel mark first passed in 1912. Technologic advances in the manufacture and utilization of cement have paced the increase in output, but more important perhaps is the benefit upon other industries. Largely in consequence of the increased use of cement, the production of sand and gravel has trebled in volume, a tremendous growth has occurred in the use of crushed stone, and great quantities of otherwise worthless slag are finding a profitable outlet as aggregates for mixing with cement to make concrete To show the inter relationship of industries it may be well likewise to note that all these industries owe much of their growth to the demand for good roads created by the automobile and conversely that the number of automobiles and sales of gasoline wherewith to run them would never have expanded to their present proportions had we been unable to use these materials for making good roads cheaply.

The foregoing examples cover only the industrial minerals discussed in the analysis and forecast made by the Bureau of Mines 25 years ago. There is no need to recite similar developments in the equally broad field of metals. Enough has been said to show that progress, remarkable progress, has been made toward eliminating waste, that minerals generally can be won more economically than ever before, that consequently they cost less in terms of human effort and less in comparison with other commodities, and that our country has grown more nearly independent of foreign supplies of minerals.

TALES THE BULLET TELLS

THE value of the scientific examination of firearms evidence is well known to law enforcement officers and an ever increasing use is being made of such evidence both in the investigation and prosecution of criminal cases.

The section of the Technical Laboratory of the Federal Bureau of Investigation which is devoted to firearms identification has had a very rapid growth. Over 560 cases requiring technical study of firearms evidence were examined during the year 1937 This is an increase of nearly 400 percent over the number of cases received during the year 1934. Cases were received from every state in the Union. Over 40 percent were submitted by state and local law enforcement agencies. In many cases, a firearms examiner from the Technical Laboratory was called to appear in court to testify regarding his findings, and there has not been a single instance in which the firearms testimony has been successfully refuted. The services of an FBI firearms examiner as an expert witness are furnished as a matter of co-operation without charge to law enforcement agencies in criminal prosecutions.

The FBI Technical Laboratory is equipped to handle many different types of firearms examinations. A most common type of examination is that in which test bullets from the gun of a subject are compared with those found at the scene of a crime Such examinations are very often made with prosecution of a certain suspect being dependent upon the results of the examination. In such cases, if an identification is effected, enlarged charts are prepared in the Laboratory to illustrate the firearms identification so it can be explained more easily to the Jury.

Law enforcement agencies are more than ever before utilizing the FBI Technical Laboratory for firearms examina-

FBI Experts Co-operate with Local Officers . . . Apply Laboratory Science to Study of Evidence . . . Give Full Reports . . . Attend Local Trials

By J. EDGAR HOOVER
Director, Federal Bureau of Investigation

tions as an aid to their investigation of a crime, even though no suspect is in custody. The investigation can be matetially assisted if, from the examination of an evidence bullet, the caliber and type can be ascertained. As an aid to such comparisons, the FBI Technical Laboratory maintains a reference collection of standard ammunition specimens.

The firearms section of the Technical Laboratory also maintains a file of rifling specifications of the principal types of weapons manufactured in the United States and foreign countries. This file is of particular assistance in enabling the examiner to determine the type and make of gun from which the evidence bullet or shell was fired Exact measurements of the rifling marks on the evidence bullet can be secured if the bullet is not badly deformed. These measurements can then be compared with the rifling specifications and very often the type of gun from which the bullet was fired can be ascertained. This information can be of great value to the investigation of a case in apprising the investigating officers that particular attention should be paid to a suspect in possession of that type of weapon.

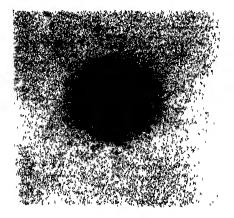
THE Technical Laboratory also maintains a reference collection of firearms which now numbers over 400 specimens. This collection offers valuable assistance for comparison purposes where unusual types of weapons are submitted for examination.

Examinations may be made with a view of determining the exact powder residue pattern appearing on clothing. Frequently, clothing of a person who has been shot is submitted to the Laboratory along with a weapon belonging to a suspect who admits the shooting but claims it was done under conditions of self-defense and at a certain distance from the murdered person. First, the

Test shots to show powder "tattooing" on cloth. Left: Muzzle of tested gun at six inches distance; and, right, three inches. (About half size) powder residue pattern, if any, around the entrance hole of the bullet in the victim's clothing is determined. Then, shots are fired with the suspected weapon through material similar to the clothing of the victim and the powder residue pattern surrounding these test shots at various distances can be ascertained. In the event a powder residue pattern similar to that surrounding the entrance hole of the bullet in the victim's clothing can be obtained, the probable distance from which the original shot was fired by the suspect can be determined.

Various other examinations in connection with firearms can be performed. Tests to determine penetration and trajectories are often conducted when the results of such tests have a direct bearing on the crime in question.

It has been suggested that local law enforcement agencies submitting evidence for examination should observe and record all information relative to the condition and position of the gun and ammunition specimens when found, always keeping in mind the possibility of developing latent fingerprints of value on the gun and ammunition specimens. The gun as well as the bullets and shells recovered should be handled with extreme care in order that the microscopic marks of identification thereon will not be distorted or obliterated. Great care should be exercised in packing the specimens for shipment and each specimen should be marked by the investigator in



order that the specimen can be identified, if necessary, in court.

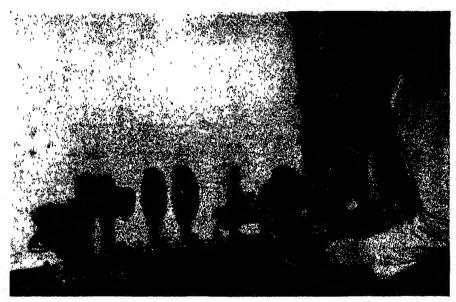
Whenever there are found marks caused by the explosive, they are examined to determine, if possible, the kind of powder used. By an examination under the microscope, the difference between smokeless and black powders may sometimes be determined. The grains of black powder appear to resemble coal in shape and are black or brownishblack. The grains of smokeless powders are made in particular shapes which enable them to be identified by use of the microscope. Many of them are formed into tubes, like spaghetti, or ribbons, which are then sliced to make the powder. Smokeless powders are usually entirely consumed by the explosion, whereas black powder usually leaves a residue.

The distribution pattern of burned and unburned powder around the hole made by the entrance of a bullet is useful in estimating the distance of the weapon from the object. If practically no "tattooing," as this is called, appears around the entrance hole, it is assumed that the weapon was held more than two or three feet from the object. The amount of spreading of the powder marks from the entrance hole indicates, with reasonable accuracy, the distance at which was held a weapon fired at less than two feet. That is, these distances vary for the different calibers, powder charges, lengths of barrels, and amounts of wear. When it is ascertained what kind of ammunition was used in a particular case, and the weapon is found, then by using the same ammunition, tests may be made through which it may be estimated at what distance the weapon was held to cause "tattooing" similar to that observed.

BY chemical analysis also, the nature of the powder may be determined. In this connection, the fact that the powder contains nitrates or nitrites enables a very sensitive chemical test to be used. A solution composed of diphenylamine and concentrated sulfuric acid applied to the powder marks indicates the presence of nitrates or nitrites by an intensely blue color. This test is sometimes useful in determining whether a death is a suicide or a murder, by indicating the presence of burned powder on the hand, from which it is "lifted" by paraffin.

As an example of FBI co-operation with local peace officers, consider this recent case. On January 3, 1938, Everett B. Hughes of Pueblo, Colorado, shot and killed his wife. He was subsequently arrested and confessed the shooting but strongly maintained that he had acted in self-defense.

Hughes presented the following version of the crime—a version which was difficult to controvert because there were no eye-witnesses to the shooting:



An "evidence" bullet is clamped under one objective of the comparison microscope, a test bullet under the other. Adjustments bring markings into juxtaposition

His wife, the victim, hated him and had threatened to leave him in favor of another man. On the night of the killing she had become particularly belligerent and had seized a revolver and had started advancing toward him, giving every indication that she intended to kill him then and there. He had no chance to escape, and being in fear of immediate death, he had seized a .22 rifle standing nearby and had fired a shot which passed through her head and caused her immediate death. He was then extremely frightened and took the victim's body to a spot in the country nearby where he buried it in a shallow grave

Hughes claimed that the burial was not occasioned by a feeling of guilt but was merely the natural consequences of his fright.

The Sheriff's Office at Pueblo, Colorado, believed that this was a cleverly planned and deliberate murder and intensive investigation was launched into the circumstances surrounding it.

It was found that Hughes had, a few days before the murder, secured from the victim a number of sheets of paper bearing her signature on the bottom. He had secured this writing under pretext, advising his wife that they were to be used to write verses on in connection with festivities in the Hughes home on New Year's Eve. Hughes had written a few verses on these slips of paper, but he had kept some and had written typewritten letters to his son and daughter over the victim's signature, which stated that the victim hated him and was soon to leave him. He had even typed a letter to himself which contained a similar message. These circumstances indicated that Hughes had been planning the murder of his wife for some time.

Examination at the scene of the crime indicated to the investigating officers that the murder had been brutally and quickly executed. Although Hughes

maintained that his wife had been shot while moving toward him in one part of the house, a chair, in another part of the house, contained stains that resembled blood. It appeared that Hughes had shot his wife while she was sitting in this chair unaware of danger.

The section of the chair containing stains, and the .22 caliber rifle belonging to Hughes, were transmitted to the Technical Laboratory of the FBI for extensive analysis and tests. Findings of the examiners were furnished to the Sheriff's Office at Pueblo, Colorado, and two of the examiners were present as witnesses when Hughes was tried for murder in March. The expert who made the examination of the chair testified that the chair contained stains of blood. This testimony nullified the statement of Hughes that the victim had been shot in another part of the house while moving toward him.

OTHER testimony was given by a firearms identification examiner from the laboratory to the effect that Hughes' gun had fired the shot which took the victim's life. Further testimony given by this examiner was of vital importance in attacking Hughes' version of the crime. As a result of tests conducted in the laboratory, he was able to state that the gun used in the murder would make a powder residue pattern similar to that which surrounded the victim's fatal wound only when held within less than one-half inch from the object through which the bullet passed. This absolutely contradicted Hughes' statement and gave valuable support to the State's contention that Hughes had held the gun almost in contact with the victim's head while she was sitting in the chair, possibly sleeping, and had then pulled the trigger. Hughes' story of shooting his wife while she was advancing toward him and still at some distance was thus discredited.

Dominating, even before completion, where they will be the center of attraction at the 1939 Fair

Steel in the Theme

New York World's Fair Theme Center... Perisphere and Trylon... Design and Construction Presented Unusual Engineering Problems... Unique Structures

THE most unusual sight at the New York World's Fair of 1939 will never again be more than a memory. At least that is the opinion of those engineers, designers, and construction men who had a part in fabricating and erecting the steel for the Perisphere and Trylon, Theme Center of the Fair

Whoever said that "looks are deceiv-



Factory test-assembly to assure fit of lower part of the Perisphere. Below: The Trylon starts upward as Perisphere supports are erected

ing" might have had the Perisphere in mind. Externally, this huge sphere is indeed the essence of simplicity, but internally it is one of the most complex engineering jobs ever tackled and completed successfully.

The Trylon stands as a sentinel over the Theme Center's major structure. It will function during the Fair as a direction finder for traffic from all points of the compass. Traffic control in the Fair grounds proper will be guided from this tower. But from an engineering point of view, the Trylon follows customary practice in design and construction.

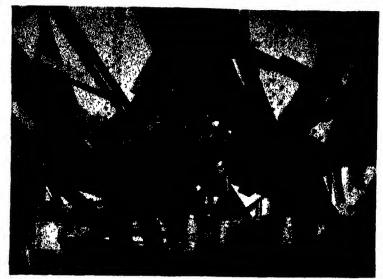
"Never in our many years of constructing bridges, buildings, and other steel structures in practically every country in the World and under all manner of weather and climatic conditions, have our engineers ever met with a problem more unique or interesting than the Perisphere," said L. A. Paddock, President, American Bridge Company, subsidiary of U. S. Steel Corporation.

Although the Perisphere will appear as a single globe when finished, it is actually a sphere within a sphere. In this structure, however, the two spheres do not have a common center. The inner sphere, which will contain huge revolving platforms, is raised a distance of three feet, although it will be attached firmly to the outer sphere by means of trusses to form a single shell. This type of construction was necessary in order to provide space for the heavy drum girders and other steel members which are required for the support of 9,000,-000 pounds which the Perisphere will weigh when finished.

"In buildings of today, comparatively few of the structural steel members are curved, but in this Perisphere all pieces, except columns and center plates, will have curved or warped surfaces to fit the contour of the spheres, and it is these conditions which, in certain instances,

Large, assembled, curved girders are lifted into place and rivetted as the Perisphere begins to show its shape





gave our engineers mathematical head-aches," Mr. Paddock said.

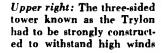
In order to make absolutely sure that every piece would fit exactly as planned by the engineers, the main trusses were assembled and the field splices reamed while assembled in a jig at the Ambridge, Pennsylvania, plant, and then dismantled for shipment to the Fair site.

A huge ball such as the Perisphere, standing as high as an 18-story building, will present considerable resistance to the wind. This factor introduced one of the important problems. When finished, the Perisphere will be able to withstand a wind of 90 miles per hour. There is nothing alarming in this, however, for although a wind of this velocity produces a pressure of 30 pounds per square foot on the flat surface of a bridge truss, it produces a pressure of only 15 pounds per square foot on the surface of a sphere, as was determined in wind-tunnel tests. Therefore, there need be no fear that the Perisphere will blow off its pedestal and go bouncing across the meadows.

The Trylon, which towers 700 feet high—taller than the Washington Monument—is unusual among tower structures because in the past they have generally been left open so that the structural steel is visible and so that they would offer a minimum of resistance to the wind. The covering on the Trylon made it necessary to introduce added strength in structural steel to overcome wind resistance, but even so, the top of the Trylon may sway through an appreciable arc as do all structures of great height.

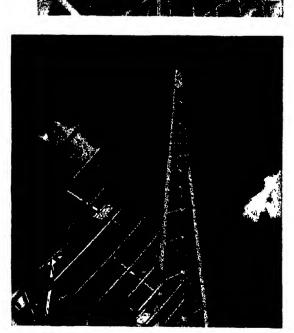
In order to support the extreme load of the finished Perisphere, including the thousands of people who will visit it hourly, the eight columns holding it up rest on mats of reinforced concrete 12 feet below the ground, and these mats are themselves in turn supported by 528 creosoted, 90-foot, wooden piles, driven down into the swampy soil.

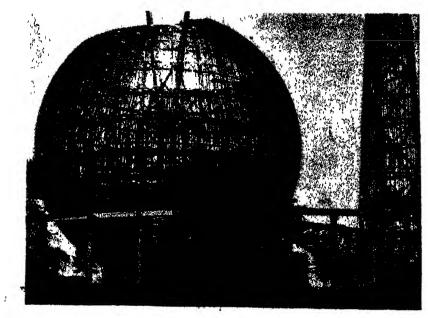
An idea of the size and weight of Perisphere structural steel may be gained from this photograph of rivetting operations under the buge sphere's curve near the base

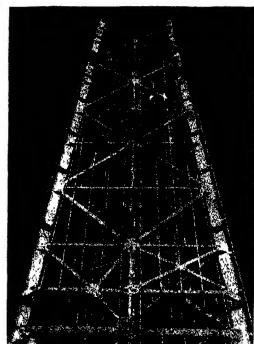


Right: Pointing high into the air, the Trylon steel receives the first of its covering, or outside wall, from the top down

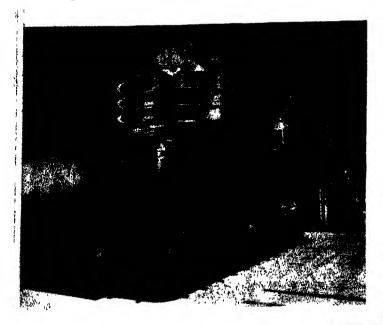
Below: Still unfinished—the two theme structures, the bridge that connects them, and the spiral ramp, or helicline. All these will be covered







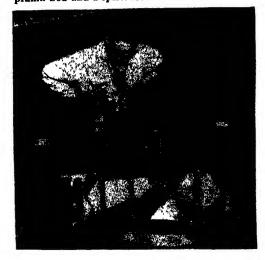
A BILLION GALLONS A DAY



Left: One of the electric motor installations of the Colorado River Aqueduct pumping system, by means of which water will be delivered from the Colorado River through 242 miles of canals, tunnels, conduits, and siphons to Los Angeles

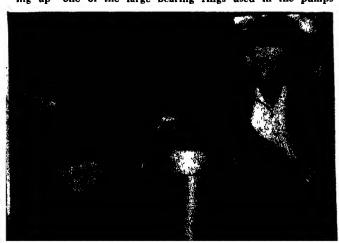
WHEN the Colorado River Aqueduct is completed a few years hence, 45 huge electric motors will drive pumps to lift 8,300,000,000 pounds of water daily and deliver it from the settling basin above Parker Dam to Southern California. The total height through which this water will be lifted is 1616 feet, to be accomplished in five steps, nine pumps working at each pumping plant. The pumps, set below water level to be self priming, will be connected to the motors through 40-foot-long steel shafts. Details of this engineering feat are shown in the accompanying photographs.—Andrew R. Boone.

Below: Since the pumps are connected to the motors through long shafts, the scroll cases of the pump units are accurately leveled by a plumb bob and a spirit level on horizontal beam

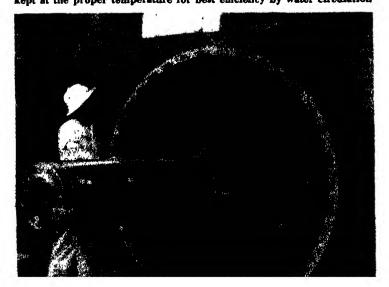


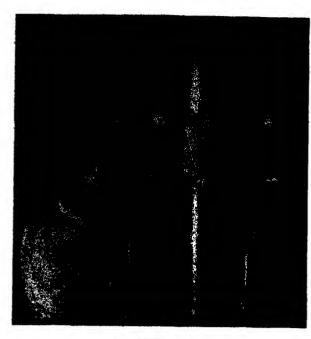
One of the scroll cases within which the impeller of one of the huge pumps will rotate. These cases, placed below water level, will be set in concrete. The impellers will throw water outward and force it upward through pipes

Below: Pump replacements and repairs will be difficult and expensive, so the greatest care is taken to insure proper running fit between bearing surfaces. Here two engineers are "miking up" one of the large bearing rings used in the pumps

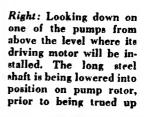


Below: The 35-ton rotor of one of the electric motors which are capable of developing 12,500 horsepower each. When these motors are in operation they will be cooled by air moving in a closed circuit and kept at the proper temperature for best efficiency by water circulation





Left: Throughout the entire installation of the pumping equipment for the Aqueduct, the most modern testing instruments are in constant use to guard against imperfections. Here a technician is using an electrical micrometer to true up one of the motor shafts





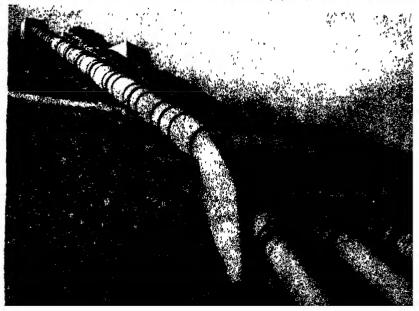




Large steel pipes used in the Aqueduct are X rayed to be sure that no flaws are present which might later develop disastrous leaks. A close-up view of the X-ray tube is shown in the circle at the left



Below: From the intake in the settling basin, water is delivered through three lines to a transition chamber, from which a single pipe leads toward California



Welder and streeted joints in the steel pipe are further scaled against losings by an application of hot far



A MONTHLY DIGEST

DANGER IN LOW VOLTAGE ELECTRIC SHOCK

LOW voltage shocks of even 12 volts can be dangerous, H. W. Arlin of the Westinghouse Electric and Manufacturing Company told a meeting of the Safety Congress

Despite the general belief among workmen that voltages up to 110 to 220 volts cannot produce fatal shock unless a man has a weak heart, Mr. Arlin cited reports on tests conducted by various organizations which show that when an electrical circuit is completed through a wet contact, any voltage in excess of 12 volts is dangerous—Science Service.

NEW BUILDING MATERIAL

BY treating with lime the waste liquors from the pickling of steel, a new type of building block having valuable properties is being produced. Steel mills have had difficulty in the past in disposing of the waste acid from the pickling of steel since this cannot be dumped into streams. The preparation from this waste of a satisfactory building block is expected to convert this liability into an asset. The blocks, marketed under the trade name of Ferron, consist principally of calcium sulfate with an admixture of oxide of iron. They are light in weight and possess some advantages over customary gypsum blocks although they have a brown color.—D. II. K.

MICROSCOPE LENS: PLANACHROMAT

AN important forward step in lens-making and the end of a long period of research is marked by the announcement, from Carl Zeiss, of the Planachromat, a new microscope objective which gives equal sharpness in definition throughout the whole field of vision. Lenses just received from the laboratories in Jena are considered to be a definite improvement on microscope objectives available up to now

Heretofore the field of magnification could be made flat only at the cost of lessening definition at the center While the spot at the center of the field was sharply in focus, the field became increasingly blurred toward the edges. Scientists had to be satisfied with having the utmost clarity at the center of Conducted by F. D. Mc HUGH

Contributing Editors ALEXANDER KLEMIN

In charge, Daniel Guggenheim School of Aeronautics, New York University

D. H KILLEFFER Chemical Engineer

the field at the expense of the surrounding area, rather than equalized but lessened definition

At present the new lenses are available in two magnifications, 9x and 40x, or the low and the medium members of the usual battery of dry lenses

SHOCK ABSORBER FOR STEEL

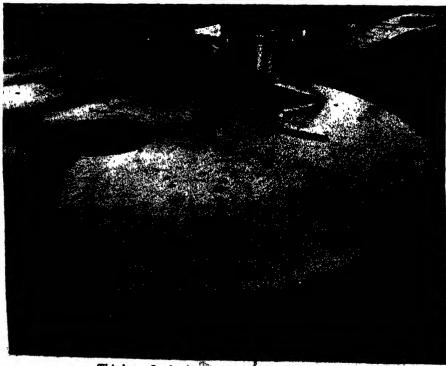
THE 190,000-pound flywheel shown in our illustration is being "faced" to a perfect circle in the East Pittsburgh works of the

Westinghouse Electric & Manufacturing Company before it goes to work as a cushion of power in a steel company's blooming mill Part of a 6000-kilowatt motor-generator unit built by Westinghouse for the steel concern, the flywheel will maintain the generator at a steady power output despite peaks and recessions in load requirements as steel billets are pressed between the mill rolls.

RIFLE SHELL FIRE ALARM

LONG-rific shells of .22 caliber and made by Remington, primed, but with no lead bullet or powder charge, are now being used on airplanes in connection with a fire alarm system. The shells are mounted at strategic points about the engine, and from them tubes lead to the instrument panel Flame of heat of 250 degrees explodes a shell, flashes a signal, sounds an electrical

When the force of the explosion flicks the red signal light, the pilot releases, through distribution pipes, carbon dioxide gas which



This huge flywheel will absorb shocks in a steel mill

envelops the engine and snuffs out the fire.

The alarm system is valuable on planes with outboard motors on the wings where a flare in a motor housing could not easily be

This new device has also been constructed to operate an automatic fire-extinguisher, from which the carbon dioxide gas is released at the instant of the explosion.

Many American-built transport planes are equipped with this device. The Argentine Government recently purchased 100 planes for its army and navy, 60 of which are equipped with the Lux Fire Detector System, which is manufactured by Walter Kidde and Company.

SWEET SMELLS

A HUGE outlet for sweet smells in the cigarette industry. Although frankly perfumed cigarettes have only a small market, every widely used cigarette is flavored; that is, it contains some spice, extract, essential oil, or sugar that will modify the taste and odor of the tobacco. In 1929, for instance, a favorite was coumarin; one manufacturer found that maple sugar gave somewhat the same smell and used 4,000,000 pounds of it in a year.—Technology Review.

ONE-MAN SUBMARINE

RARLY rising residents of Michigan City on a recent Sunday morning gaped in astonishment at a strange object that was passing through the streets as they stepped out to gather in the morning milk. The contrivance looked for all the world like a huge speckled trout mounted on an automobile trailer—a trout with adenoids, for its mouth appeared to be open; a trout with two baleful-looking eyes, no fins and a queer kind of tail.

Some of the curious threw on a few clothes and set off in hot pursuit. Down at the water front they got a better look at the contraption which turned out to be a one-man submarine. It was about eleven feet long, three feet high, and about two feet through the middle.

According to Barney Connett, a garage mechanic by trade, the body was made of



Steel trusses, usually hidden from sight in ordinary building construction, will remain exposed in the "inside out" exhibit building of U. S. Steel at the New York World's Fair. Here is shown the skeleton taking shape, ready to support a stainless-steel dome 66 feet high and 132 feet in diameter. The shape of the building carries out the motif of the Fair's Theme Center which is described in some detail on page 24 and illustrated on the front cover of this number

steel and weighed just over a thousand pounds. The power plant, he said, consisted of five regular Kathanode automobile batteries, four of which furnished the power for the 38 mile crossing of Lake Michigan.

When everything was ready, Barney low ered himself into the cramped interior and pulled down the hatch cover which looked like an over-size pith helmet with a flag pole on it. The flag pole, of course, was Barney's periscope.

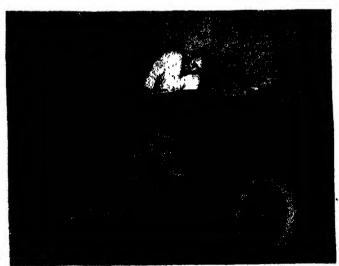
The little craft began moving silently out into the lake and Barney submerged until only the periscope was visible from shore. The inventor claims his sub will go to a depth of 31 feet, but you can't go down that far with a four-foot periscope—not and still see where you're going. So Barney stayed within about three feet of the surface Behind him came the Idler, a 65-foot sloop carrying two professional diver—just in case.

About eight miles out from Michigan City the under-water craft ran into a storm, but her batteries pushed the boat steadily through the rough water.

When the submarine purred into Navy Pier, Chicago, and Barney climbed out, the sub was still going strong, he said, but he was exhausted—and happy. He had done what he set out to do

FINGERPRINTING CHEMICAL COMPOUNDS

RAY diffraction patterns produced by crystalline compounds have long been used in chemical investigations. Full usefulness of these patterns, which are characteristic of the material investigated, has been impossible in the past because no sure method of indexing multitudes of patterns existed. Recently such a system has been devised by chemists at the Dow Chemical Company and applied to the patterns produced by a thousand different chemical compounds.





The one-man sub ready to be towed to the water, and, right, under its own power

This system of classification, which is capable of extension to other compounds, provides a method of identifying chemical compounds as sure and accurate as fingerprinting identifies persons.

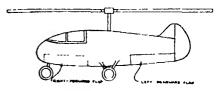
Diffraction patterns are made by placing a small specimen of powder of the unknown material in a narrow beam of X rays which are thereby refracted to make a record on a photographic film. This record consists of lines in different positions, characteristic of the arrangements of atoms in the material investigated. The important value of the method lies in the fact that it will detect and make a permanent record of the various materials present in a mixture without destroying the sample or otherwise affecting it—D, H K.

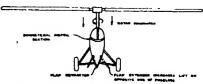
THE HELICOPTER TRIUMPHANT

AT the Franklin Institute, under the auspices of the Philadelphia Chapter of the Institute of the Aeronautical Sciences, there was recently held the first meeting ever devoted exclusively to Rotary Aircraft Beginning with an introductory paper intended to give a comprehensive view of the entire art by the Aeronautical Editor of Scientific American, papers were delivered by almost all the outstanding exponents of the Autogiro, the Gyroplane, the Convertaplane, and the helicopter. Space will permit us to cover only the most significant features of this highly successful gathering

highly successful gathering

The honors of the meeting went to the helicopter W Laurence Le Page showed a film of the Focke Helicopter which we have described in these columns. The film was positively astounding. The machine per-





Side and front views of Hainer's rotor plane employing side flaps

formed the most marvelous evolutions inside a hall, flew forward at 75 miles an hour, backward at 18 miles an hour, hovered, turned around its own axis, all under perfect control That highly distinguished aeronautical engineer Grover Loening confirmed the astounding characteristics of the machine. On one occasion he stood beside Professor Focke, when an inexperienced pilot was in the cockpit Not knowing what to do, he brought his machine completely to rest some ten feet from the ground, and called out "Was Soll Ich Thun?"!

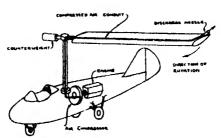
But although the Focke-Wulf helicopter has broken all records, and constitutes a remarkable achievement, the helicopter is still in the rapidly evolving stage and many other forms will doubtless present themselves.

As we had occasion to state previously,

it is highly desirable to have a helicopter with the lifting qualities and the simplicity of a single large lifting airscrew. But since the large airscrew turns slowly its reaction torque is high. This is how two excellent engineers propose to meet the reaction torque while using one rotor:

Raoul Hafner (of Hafner Gyroplane fame, a windmill type which has been most successful in England) is about to construct a craft in which a relatively small rotor will be used, turning rapidly so as to give efficiency in forward flight and a relatively small reaction torque. Combined with this Mr. Hafner will use a long, slender fuselage, provided with two side flaps front and rear. These flaps, displaced in the downwash of the rotor, will produce lateral forces, which will take up the reaction torque with a minimum of air drag. This ingenious idea was very well received.

Professor Montgomery Knight suggests a different plan. He will employ a single blad-



Knight's single-blade rotor plane

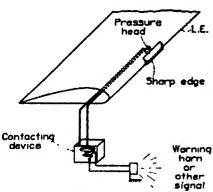
ed airscrew (suitably counterbalanced) and instead of using a mechanical transmission will supply compressed air to the tip of the blade. The air ejected from the blade will drive it around, so again reaction torque will be eliminated in a highly novel form of direct lift machine. This idea was subjected to many criticisms such as the difficulty of balancing a single rotor and the fact that another conversion of energy is introduced (instead of the efficient tilting forward of the rotor to produce propulsion) and a very inefficient one at that.

Indicative of the wide interest existing in this art is the fact that Edward Noble, chairman of the Civil Aeronautics Authority, addressed the gathering at a banquet which took place during the highly successful and interesting symposium.—A. K.

A STALL WARNING INDICATOR

THE "stalling" of an airplane wing, which occurs when the nose is raised too much, is highly undesirable, since it may lead to loss of control, falling off on one wing, and sometimes to an unpleasant spin. With stalling of the wing, the airspeed drops and in horizontal flight the airspeed meter is in itself a stall indicator. But in making a turn, the lift is greater than the weight of the airplane, because centrifugal forces have to be met, and the stalling speed is in turn higher than the stalling speed in ordinary, straight flying. Thus the airspeed meter becomes a very poor guide to safety in maneuvers.

To meet the difficulty the N.A.C.A. has developed a special stall indicator. Near the tip of the wing, close to the leading edge and just above its surface, there is placed a Pitot or pressure head. At the leading edge



Airplane stall indicator

of the wing, ahead of the Pitot, a sharp edge is fitted. With this introduction of the sharp edge, a local stall and loss of pressure at the Pitot tube occur well ahead of the general stall of the wing. When this local loss of pressure occurs, a contacting device automatically closes an electric circuit, and an electric horn in the cockpit gives a warning blast.

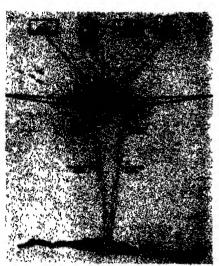
Full flight experiments at Langley Field, in a small Fairchild airplane, have shown that while this machine stalls at 42 miles an hour, the horn blows at 59 miles an hour The pilot thus receives a warning well ahead of the danger zone.

There are minor difficulties to overcome. The pressure tube must be heated to prevent ice formation, and the device must be so arranged as not to increase air drag—the perpetual enemy of the airplane constituctor. Nevertheless, it is clear that this ingenious and simple device is a valuable safety measure—A K

ABSOLUTE ALTIMETER AND COLLISION INDI-CATOR

IN our opinion the development and successful testing in a Boeing transport plane of an absolute altimeter and collison indicator is one of the epoch-making advances in aviation. The absolute altimeter was developed jointly by Bell Telephone Laboratories, Western Electric, and P. C. Sandretto, Superintendent of the Communications Laboratory of United Air Lines.

The basic principle of the device can be



Simplified diagram of operation of the newest radio absolute altimeter

simply stated. A short-wave radio signal is transmitted from the airplane to the earth. The signal is reflected back from the earth. the time elapsed in the reflection of the signal is measured, and this time is translated into a direct and accurate meter reading of the plane's altitude in feet. Due to the use of an ultra-high frequency the altimeter is entirely free from static interference. Despité any weather conditions, or irregularity of terrain, the pilot can read his height directly above the earth whether it is only a few feet or is thousands of feet. A warning signal can be incorporated in the apparatus. Also, the altimeter can be directed forward at any desired angle, serving then as a collision indicator against mountains or other obstructions. The weight of the apparatus is only 40 pounds.

This sounds very simple, but our readers will agree that an enormous amount of research work must have gone into the invention

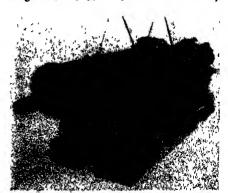
A really technical explanation is not yet available. No doubt it will find its way eventually into the technical journals. But the accompanying diagram will serve to give a general understanding of its functioning (See lower right drawing, opposite page.)

In this diagram, A is the radio transmitter operating on a frequency of 500 megacycles, the highest frequency ever used for practical purposes in short-wave radio The transmitter is connected to the transmitting antenna E only 12 inches long, located below the wing of the plane and about eight feet from its center This transmitting antenna sends a signal G to the ground J, not in the form of a pencil or beam of radio waves, hut in a large hemispherical pattern. The ground J reflects this radio energy back to the plane where it is received by the receiving antenna F. The radio receiver D, connected to the antenna F, receives a wave K from both the transmitted wave and the reflected wave. The interference thus created is measured by the device C, and by suitable calibration the measuring meter gives a reading on the "Terrain Clearance Indicator" B.

We hope that the instrument proves just as satisfactory in actual service as it has in the laboratory and in the experimental flights.—A. K.

Unitwin Power Plant

DETAILS are now available of the Unitwin power plant in which two Menasco Buccaneer engines will be coupled to a single propeller in such fashion that when one engine fails the other will still keep the airscrew going. The advantages of such an arrangement are obvious. With the ordinary



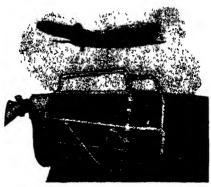
Unitwin



A mobile airport provides mechanical servicing facilities in the field

twin-engine power plant, with each engine mounted out on a wing, the failure of one engine sets up a turning moment which has to be rapidly counteracted by the pilot Also, long leads have to be provided from the pilot's cockpit to the engines. With the Unitum, all the safeguards against failure of one engine are provided, yet the turning moment is completely eliminated. Flight on one engine is thus much more of a certainty

The Unitwin engine is shown in one of our photographs. Two six-cylinder, aircooled, inverted engines are placed side by side, with the propeller shaft exactly between them. The two engines are geared together to the common propeller by means of an over-running clutch (which has been used in many lines of industry, as well as in



Installation of a Unitwin power plant in a low-wing Vega monoplane

free-wheeling and over-drive units in automobiles). When the engine on either side quits, the over-running clutch immediately brings it out of engagement. Each engine has a flywheel incorporated in the gearing unit in order to prevent the motor from stopping when idling.

Another of our photographs shows the installation of the new power system in the nose of the low-wing Vega monoplane, which is being rushed to completion by Vega Airplane Company, a subsidiary of Lockheed. The nest looking Vega will carry five or six passengers in all the comfort of the largest airliner and will be particularly useful on

feeder airlines. The Vega should also be very interesting to private plane owners seeking the maximum of twin-engine safety. With a useful load of 1729 pounds, and a gross weight of 5400 pounds, the new Vega will have a maximum speed of 210 miles per hour at 7500 feet altitude, and a cruising range of 600 miles—A. K.

A MOBILE AIRPORT

THE wars in Spain and China and the records of other military operations indicate that in air warfare the provision of a limited number of airports and landing fields may not be enough. It appears desirable to provide a mobile airport or flying base which can be set up anywhere, travel over almost any terrain, and provide ample facilities for the repair or maintenance of aircraft. Mr. K. W. Couse, of New Mexico, has in very logical and thoroughly engineering fashion developed a traveling or mobile airport which has been exceedingly well received by all the authorities who have examined it.

Mr. Couse has made no startling inventions or evolved intricate gadgets. He has merely used a high degree of common sense. A glance at the photograph of the mobile airport will indicate its general character. Here are its specific features and accomplishments:

With two driving rear axles, powerful gear reduction, and removable steel tractor treads, the Couse mobile airport can climb. continuously, up a grade of 35 percent. The wheel base is shorter than in standard truck designs, which makes for roadability and the ability to make very sharp turns. The short wheel base also allows an irregular road surface to be followed. The special design of the chassis brings the center of gravity down quite low, which means more steadiness on the road. As the Couse unit is specially designed to house heavy equipment and machinery, it can carry large weights without the over-all weight of the unit becoming excessive. The two spare wheels in front also serve as a fine bumper.

So much for the automotive side of the picture. From an aviation point of view

there are many desirable features. The neatly installed shop equipment includes a lathe convertible into a milling machine. welding equipment; other machine tools, a generator with ample capacity for operating the various tools, drill presses, hand tools, and so on-everything needed for field repair of aircraft. The sides of the vehicle swing out and up to provide shelter in inclement weather, with the addition of a tarpaulin at the end of the hinged roof. There is a crane and an engine workstand, as well as radio equipment for both transmitting and receiving A searchlight at the front of the vehicle can be made to indicate the direction of the wind. There are also two other searchlights, so that three vertical beams can be set up to mark out the boundaries of an emergency field -- A K

IMPROVED STREAMLINED WHEELS

THANKS are due to the Army Air Corps for the accompanying photographs of a streamlined airplane wheel and tire with smooth contour. For a non-retractable chassis, the advantage of a streamlined wheel is



so obvious as to need no comment. To improve operation on soft ground the Air Corps engineers have widened the tire contour at the tip of the tread as the picture indicates. To reduce the opening in the wing with a retractable chassis, the designers are making the wheels smaller and smaller, and quite recently the standard 60-inch size (employed on large bombers) has been reduced to 56 inches diameter. For a craft weighing something like 70,000 pounds, the utmost efficiency and greatest reduction in size are absolutely essential.—A. K.

CIVIL AERONAUTICS AUTHORITY

POLICIES of the Civil Aeronautics Authority are not yet clarified, but its members have made an impression of earnest good will and willingness to work hard. The addresses delivered by members of the Authority during National Air Travel Week were well informed, sensible, and to the point. In particular the remarks of the Chairman, Edward J. Noble, broadcast from Annapolis, Maryland, during Air Week,

brought out the progress in air transport in striking fashion. Mt. Noble compared air transport of ten years ago with that of today

Ten years ago, there was no information on the upper atmosphere. Now we talk about flying in the stratosphere and the substratosphere, in pressure cabins, and think nothing of it. Ten years ago there was little or nothing available in radio, instruments,



Above and left: Views of the improved streamlined airplane wheel

sound proofing, aviation medicine. Other contrasts are equally marked

Yet in a country of 130,000,000 people only 2,500,000 fly for any reason whatsoever. The airlines check in a million passengers a year, but they know that the same people are flying frequently and they actually get only a quarter of a million passengers.

Fear still temains. As fear is vanquished, further progress will be stupendous or colossal, or any other Hollywood adjective (ting the various well developed aids to navigation. Mr. Noble summarized the safety situation in the following words: 'fi is 300 percent safer to fly now than in 1930. The airline ratio is one fatal accident to each twelve million miles of flying. At that rate you can fly around the world four hundred and eighty times before you need to be afraid of flying into it! That figure is absolutely correct and it is something for timed souls to think about "- A. K.

GLASSY LANDINGS

RITING in Aero Insurance News Letter, Jerome Lederer states that judging height accurately when alighting on perfectly calm water is practically impossible. Within the last year, about 50 pilots and passengers have lost their lives in various parts of the world because of "glassy landings". Under glassy conditions, the pilot should not guess at height and follow the conventional maneuver of gliding down and then flattening out a few feet from the surface. He may flatten out too late, and nose into the water with possibly disastrous consequences. What he should carry out is a "power stall." At about 50 feet from the surface of the water,

he should open up the throttle of the engine a trifle, and pull the nose slightly above the horizon. The plane will then lose altitude slowly in an almost stalled attitude. The sub-sequent contact with the water will be harmless, although to land in a power stall on the much harder ground might not be so judicious.

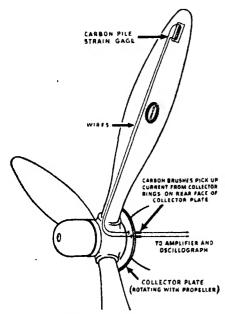
Incidentally Mr. Lederer argues that land airports should never be located on islands or terrain largely surrounded by water because of this same difficulty of judging height while still over the water and making the approach to the field -A K.

PROPELLER STRESSES MEASURED IN FLIGHT

IT is not the steady load which causes failure of a metal propeller, but vibratory stresses due to the uneven torque cycle of the engine or its dynamic unbalance. The reliability and safety of the propeller have therefore been increased by intensive study of its vibration. Hamilton Standard have advanced this study of propeller vibration to such a degree that in the 20,000 controllable pitch propellers built in recent years not a single failure at the hub has been reported, and the less serious blade tip failures are very few in number.

Now Hamilton Standard announces an ingenious and simple method of measuring the stress at any point of the propeller bladeduring flight, which should advance knowledge and hence safety still further

The device is illustrated diagrammatically in one of our drawings. It depends upon the phenomenon that certain materials in crease and decrease their electrical resistance in direct proportion to the loads or



For measuring propeller stresses

stresses imposed upon them The resistor or strain gage used in this case consists of a "carbon-pile" strip approximately two inches long, a quarter of an inch wide, and one sixteenth of an inch thick. This carbon pile, cemented lengthwise to the propeller blade but insulated from it electrically, is attached at its ends to two fine wires which carry direct electrical current. As the propeller blade stretches under load, the resistor stretches with it, and increases in

electrical resistance so that the current flowing through the system varies. This varying current is used to operate an oscillograph which consists essentially of a coil between the poles of a magnet. The coil moves in the magnetic field, following the change of the electric current in the resistor. A tiny mirror is mounted on the moving coil, and a fixed beam of light is focused upon the mirror As the coil moves, the miiror picks up the beam of light and flashes it up and down on a strip of light-sensitive paper. If the sensitive paper is moved at a given speed a wavy line appears, with the height of the waves directly proportional to the stress in the propeller. The permanent record thus obtained can be studied at leisure and gives the engineer an exact idea of what is happening in the blade. An advantage of the instrument is that it lends itself to remote control and is portable.

PALLADIUM PRINTS

PALLADIUM is being used in solution for hand-sensitizing photographic papers in order to print high-quality photographs of the sort formerly obtainable only by using platinum.

GLARE-FREE DESK LIGHT

VISION without glare, bright illumination with no eye fatigue, greatly improved contrasts in viewing black and white illustrations, and truer, richer perception of colored objects, all this is accomplished by a new polarized-light lamp which can be used on desk or table. It is of moderate



Polarized light-no glare

height and has a circular metal shade with an internal reflecting surface. All light is thrown downward so that no direct light reaches the eye.

A new transparent plastic material polarizes the light as it is reflected downward by the metal shade. This new plastic polarizer, known as "Pola-Ply," was especially devised for this light by Alvin M. Marks of Polarized Products Corp. It is a composite plastic sheet containing no polarized crystals and which polarizes by virtue of the transmission of light through many layers of extremely



A glass-topped turn-table was devised by Goodrich engineers to make possible direct photography of the action of an automobile tire tread on a film of water. The turn-table is revolved while a camera placed beneath it takes photographs of tread action, showing in the laboratory the results of braking and other factors to which the automobile tire will be subjected as it rolls along the pavement

thin isotropic plastic sheets. These sheets are sealed tightly during manufacture

This unique material can be produced in unlimited quantities for a small cost per square foot, and it promises to have many uses in the lighting industry.

SULFUR AIR POLLUTION

RECENT studies of the concentration of sulfur dioxide in the air in five important industrial areas of the United States show that this is a negligible factor in its physiological effect. As a result of some 50,000 separate analyses covering a period of 15 months, with samples taken within a 15 mile radius of the center of the area, the following figures were obtained St. Louis—East St. Louis—

Average 0 128 parts per million (maximum 2 266).

Pittsburgh—Average 0.037 parts per million (maximum 0.897)

Detroit -- Average 0.028 parts per million (maximum 0,396)

Philadelphia Camden

Average 0 027 parts per million (maximum 0 424).

Washington-

Average 0 009 parts per million (maximum 0 290)

Apparently Pittsburgh, in spite of its reputation, is not the leader in this type of air pollution D. H. K.

HEAT LAMP PROVES EFFECTIVE

FOR the relief of various deep-scated congestions, the 10-wait heat lamp recently made available by General Electric has proved particularly effective and convenient in use. The lamp utilizes a lamp constructed of infra-red transmitting black glass with a reflector, and has been designed to concentrate infra-red rays directly at the point of application. These penetrating rays augment



New, compact heat lamp in use for the local treatment of congestion

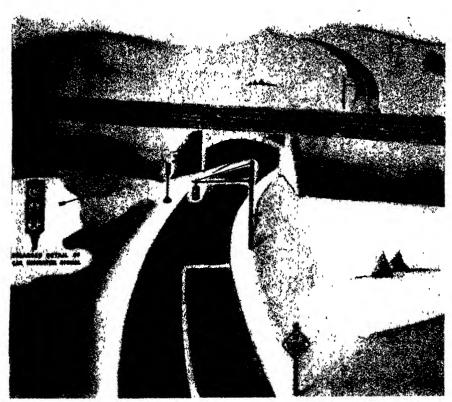
the normal blood processes, thereby relieving congestion

Simple and safe to operate, the lamp is of light-weight aluminum with an ivory baked-enamel finish. It has a handy switch and permanently connected all-rubber coid. The lamp draws 10 watts at 110 volts, and may be used with either alternating or direct current. Its compactness makes it convenient to carry for travelers who may desire relief from sinus afflictions at short notice.

STATE BIRTH CONTROL PROGRAM

NORTH CAROLINA is the first state in the nation to have a birth control program sponsored by the state health department.

Nearly half the counties of the state now have birth control clinics. There has been no local opposition to the service or the method



Highway safety may be increased by installations such as this one

adopted for rendering it. Social, religious, and other civic leaders have given their full endorsement and co-operation.

The patients have been selected from poor married women who need to limit the size of their families or space their children for the sake of their own and the children's health. Women who are able to pay a private physician are encouraged to do so. Practicing physicians in the communities served have been glad to find that they may legally give this service to their private patients.

A total of 1141 patients have been served, with only six failures reported. In three of these the mentality of the women was very low.—Science Service.

SPEED CONTROL SYSTEM

POR dangerous curves, highway hottlenecks, underpasses, and the like, the Automatic Signal Corporation has developed an ingenious speed control system called the Electromatic Our illustration shows an installation at an Scurve underpass.

In the foreground near the speed limit sign is a vehicle detector inset into the pavement. On the right near the railroad bridge is a traffic light, with one red and one green or orange light, controlled by the detector. To the left, nearer the bridge, is a car indicator signal which, despite its position at the left, is intended as a guide for the car in the right lane. Beyond the railroad is a duplicate set of detectors and signals to guide the oncoming left-lane traffic.

The traffic light is normally red. As a car passes over the near detector, it must slow down and wait a given number of seconds until a "proceed" indication, governed by local preferences, is flashed by the traffic light. The car then proceeds into the curve and under the underpass at a necessarily reduced rate of speed. After this car passes, the traffic light automatically returns to the red, or stop, light. Adjustment is made to

take care of a number of cars travelling in the same direction at rather close intervals.

When a car has gotten the "proceed" signal from the traffic light, the car indicator signal on the opposite side of the blind spot flashes on, spelling out "c-a-r," to warn approaching drivers

DIESEL CONTROL CABS

THE control cabs of the new streamlined 6000 horsepower, Seaboard, Diesel-electric locomotives, the most powerful and longest in the world, look very different from the cabs of steam locomotives, as our illustration shows. Safety in operation is an important factor, essential controls of the Seaboard Air Line Railway's Diesels consisting of a dead-man control pedal which would automatically stop the train if the engineer's foot should leave the pedal, a throttle lever controlling the speed, a reverse lever, and an air-brake lever.

The engineer is always given immediate



In a Diesel-electric locometive cab

information as to the condition of his operating equipment. An eight-inch electric gong and illuminated annunciator box is also placed both in the cab and in each engine room to inform the engineer of any abnornal condition in the power plant or chassis. The annunciator boxes have three differently colored lenses which show if there is a hot engine, low oil pressure, or heating plant boiler failure. The alarm gong starts ringing the instant a warning light comes on and continues to ring until the engineer closes the throttle to stop the train. Windshield wipers, defrosters and visors, electric horns, safety glass, and speedometers all contribute to safety.

SWIMMING POOLS

GROWTH of algae in swimming pools is prevented by a grayish, white powder dissolved in the water. The treated water is not colored, does not stain suits, and is not objectionable to bathers.

DEATH RAY FOR INSECTS

COLD-BLOODED inhabitants of the fur of dogs and cats, of birds and their cages, lofts, and coops—fleas, ticks, lice, red mites—now have their own private death ray. A new infra-red lamp, developed by the Leray Corporation, kills all such vermin and others which infest seeds, cloth, wood, and



"Flea killer" in use

other materials. Fungus is also said to be susceptible to its killing rays, so that plants may be freed of disease fungi.

At present most of the emphasis on the killing power of this light is being placed on its use to rid household pets of vermin. Abercrombie and Fitch Company, New York sporting goods store, through whose courtesy we show the accompanying picture, advise that they are daily making very satisfactory demonstrations on dogs that are brought into the store. One treatment, naturally, is not sufficient to eradicate all vermin on an animal. The reason for this is not that all peets on the pet do not succumb at once but because the vermin often leave their "hosts" for short periods, especially after they have eaten well and are sleepy. The pet is therefore used as a lure or trap to facilitate cleaning of its quarters.

The Leray lamp is as easy to operate as a flashlight. It is held close to the animal's body, as shown in the photograph, while the operator's other hand ruffles the fur so that the light will penetrate to the skin. That is all there is to it except that often it is necessary to accustom the animal to its presence

Why Do So Many Presidents Enroll with the

ALEXANDER HAMILTON INSTITUTE?

MORE than 50,000 presidents and owners of American business concerns have enrolled with the Institute for executive training.

Why?

Because they know that organized knowledge of business is an essential

qualification to every responsible executive.

Because they know that modern business is too big to learn by personal experience alone.

Because they know that the Institute has gathered the experience of the most successful business men of America and the proved principles and methods of thousands of companies; formulated and organized this knowledge for their use.

Because they know that modern business has set new standards of executive competence and that the Institute training prepares them to meet these standards.

To Executives and Coming Executives The Institute Offers

ORGANIZED KNOWLEDGE of BUSINESS

The Institute training is not for Presidents alone—but it is planned only for executives and those who are determined to become executives. The Institute offers the knowledge and training without which no man is



qualified for executive responsibility.

For more than a quartercentury the Institute has been preparing men for business management, giving them the thorough, organized knowledge of production, marketing, finance, and accounting essential to

competent administration. Many of those enrolled have been ranking executives who recognized their need for better equipment; many others have been far-sighted men, twenty-five years of age and upward, preparing in advance for the opportunities they know will come.

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A CONTRAST IN FUNDAMENTALS		
1878 1937		1937
Horsepower installed in factories — a measure of the use of machines	•	INCREASED 14 TIMES
Jobs in factories	8	INCREASED 3 TIMES
Total factory wages	Ø	QQQQQQQQQQQ INCREASED 11 TIMES
Value of goods produced in factories	\$	\$\$\$\$\$\$\$\$\$\$ INCREASED 11 TIMES
Production per person (USA)		INCREASED 4 TIMES
Population	*	P P INCREASED 26 TIMES
Use of electricity	NONE	100 BILLION KILOWATT-HOURS ANNUALLY

by flashing it on for several short periods Death to vermin at any particular spot comes in from a fraction of a second to four or five seconds.

SYNTHETIC GLYCEROL

CLYCEROL, produced as a by-product of the manufacture of soap from fats, has become so important in the manufacture of synthetic resins, particularly those used in paints and enamels, that its synthesis is being undertaken to amplify the supply. The process of synthesis consists in chlorinating propylene, a by-product of cracking of petroleum, and hydrolysing with alkali the trichloropropane thus formed. One of the large oil-refining companies has already installed equipment for this purpose and expects to be able to produce glycerol at a fraction of its present price.—I) H. K.

MAJOR INDUSTRY

OUT of every \$100 of sales of organic chemicals in 1937, \$130 was spent for research, for which chemical manufacturers spent during the year, according to conservative estimates, \$20,000,000.

SIXTY YEARS

THE accompanying graph, prepared recently by, and used through the courtesy of the General Electric Company, presents some interesting contrasts. It shows clearly, by verifiable figures, that we are not yet quite licked b, the machine of man's own making. In fact, at the very point where the machine should have done the greatest part of its dastardly work, the evidence indicates that man is still the boss.

In approximately 60 years, the population of the United States increased 2.6 times. Had our machines of 1878 been left alone and had all other themes been equal, jobs in factories should have increased a like number

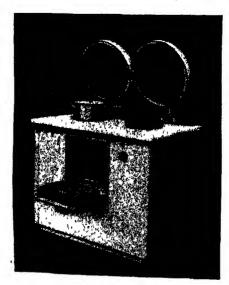
of times, or 2.6 times But jobs actually increased 3 times. That means more jobs per capita, with the machine than without. Study of the graph will indicate other illuminating improvements in standard of living, money to buy the things for the better life, and so on

Fluorides in Water Prevents Tooth Decay

PRINKING water containing fluoride, a worry to residents of certain localities because it causes a permanent discoloration of the teeth of children, known as mottled teeth, may actually be a blessing in disguise.

Children drinking this water are relatively immune to tooth decay, it is revealed by a four-year study described in *Public Health Reports* by Dr. H. Trendley Dean, dental surgeon of the United States Public Health Service

Examination of thousands of school children in South Dakota, Colorado, and Wisconsin showed that the severity of dental caries is lower in localities where the mottled enamel occurs. In fact, the severity of tooth



decay is inversely proportional to the prevalence of mottled enamel.

A special study of nine-year-old children showed that the number of children completely free from tooth decay is over five times as high where the drinking water contains appreciable amounts of fluorides as where the water is relatively free from the mottling substance.

Dentists are not ready to advise drinking of the fluoride water to prevent tooth decay, but the research raises some interesting questions, Dr. Dean points out. "What rôle, if any, does the physical structure of a tooth play in either susceptibility to or immunity from dental caries?" he asks on the basis of these findings. Is the higher fluoride content of the enamel of a mottled-enamel tooth the immunity-producing factor? Is the limited immunity due, directly or indirectly, to the well-known inhibitory action of fluorine on enzymatic processes?"

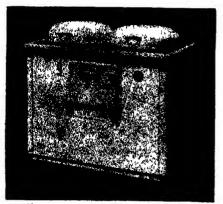
Perhaps it is not the fluoride that causes the immunity, after all, Dr. Dean points out, but some unknown constituent in water that either appears only where fluoride is present, or is in greater concentrations in water containing fluoride, or that acts to produce immunity only when associated with fluoride.

—Science Service,

FOR THE KITCHEN

OME years ago we pointed out that invention per capita was higher in Switzerland than in this country. It seems that the Swiss are as ingenious as they are prolific inventors—if we are to judge by two new patented inventions recently described to us by Mr J. Basler, who is in this country to interest American manufacturers in their production.

Electrical ranges have the disadvantage that, when starting to cook, the housewife must wait until hot plates and oven are up to temperature. The result is that cooking is very slowly done. This delay is unnecessary with the Swiss range illustrated on this page. It operates like an electric refrigerator—the current is on all the time. The body, the



Above and left: Two views of the electric kitchen range in which current is left on all the time

oven door, and covers over the hot plates are well insulated so that the exterior is comfortable to the touch. However, the housewife has only to lift one of the covers to find the hot plate heated to 270 degrees, Centigrade. Speedy cooking results.

Inside this unit is a strong, sealed tank of water which acts as an accumulator of heat. A heating element which consumes 600

watts and is turned on 24 hours of the day keeps a constant head of steam under pressure circulating under the hot plates and in the oven. An automatic regulator keeps the heat constant, turning the current on and off, as needed, exactly as does the control mechanism of an electric refrigerator. Inside the



The bottom is thicker than the sides in this latest one-piece saucepan

body of the range is also a coil connected with the water system to supply running hot water at all times.

Besides faster cooking, the advantages of this range he in lower rates for current; the use of off-peak-load, or night current; prevention of burned food because of the even, controlled heat; and other features.

The other invention consists of a stainless saucepan, the bottom of which is of heavier "plate" than the side walls, but cast as one unit Besides the well-known advantages of stainless ware, this pan will not buckle or warp. It is particularly useful on all perfectly flat hot plates of electric ranges.

FOREST FIRES

A FOREST fire every three minutes was last year's count in the United States, according to summatics compiled by the Forest Service, U. S. Department of Agriculture. The total for the year was 185,000.

Castor Oil Off the Medicine Shelf

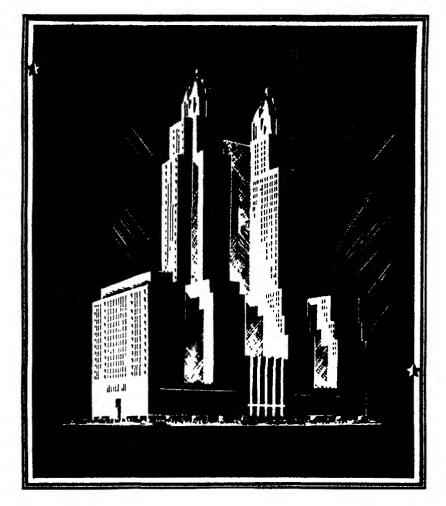
YOUNG America's acquaintance with castor oil does not include knowledge of the important fact that it is the only known lubricant which does not affect rubber. That makes it invaluable in hydraulic brake fluids widely used in modern auto mobiles. Brake fluids consist, with a few exceptions, of castor oil mixed with a solvent, such as alcohol, to make it thinner and to prevent it from thickening in cold weather.—D. H. K

BRITISH PRAISE NEW AMERICAN CRUISERS

IN the new cruisers of the Brooklyn class, the U. S. Navy possesses the best ships of their type in the world. Such is the general tenor of an article in a recent issue of The United Services Review, leading British military periodical.

In armament, protection, speed, seaworthiness, plane-carrying capacity, the new American craft are given a long lead over the Mogami class in the Japanese Navy, and even admitted to have the edge over the comparable British cruisers, the Southampton class

The main grmament of the Brooklyn class,



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15 6-inch guns, is the same as that of the Mogamis, but the latter ships have a displacement of only 8500 tons as against the Americans' 10,000, and are therefore rated as over-gunned by the British journal. They have purchased their heavy battery probably at the cost of other desirable qualities, such as armor and internal protection against damage by torpedo and mine explosions.

The Brooklyns carry four planes, and can accommodate as many as eight. This capacity, the Review comments, is far superior to that of any foreign cruiser save one in the Swedish Navy, which is a hybrid ship that has sacrificed everything to carry from six

to eleven planes.

The British observers are favorably impressed with the anti-aircraft armament of eight 5-inch guns carried by the American cruisers, which is "very similar to that carried in the Mogamis and is slightly superior, at least in theory, to that in the Southamptons."

Unlike the comparable British and Japanese cruisers, the Brooklyn class carries no torpedo tubes. These weapons have been given up in all American ships larger than destroyers. The feeling of the Review seems to be that this is no particular disadvantage, since the new cruisers are designed to act in conjunction with the destroyer flotillas, and American destroyers now building carry the exceptionally heavy torpedo armament of 16 tubes.—Science Service.

PEACE

RINGING in the first one hundred years of peace between the United States and Canada, a large nickel bell known as the International Peace Bell has been installed on the lower ramparts of Fort Wellington overlooking the St. Lawrence River at Prescott, Ontario, where the "Battle of the Windmill" was fought in 1838. Over 15 inches high and weighing more than 200 pounds, the bell is made of a special nickel alloy.

STOP-WATCH-MAN

IN presenting an honorable mention award in the Scientific Group of its Third Annual Modern Plastics Competition to the Precision Scientific Company of Chicago for its Stop-Watch-Man, Modern Plastics Magazine recognizes the design achievement made possible with plastic materials.

The Stop-Watch-Man is a tear-drop shaped holder or base for a stop watch, for use in the laboratory where workers' hands are very



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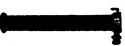
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busy and often wet with oils or chemicals. A regular stop-watch is recessed into a Bakelite molded plastic base, so constructed as to permit control mechanism to be set into the base and the watch operated by merely pressing a button. Designers Barnes & Reinecke of Chicago achieved not only a better-looking, better-functioning unit utilizing plastics, but also were able to reduce manufacturing and, consequently, selling costs, compared with an older cast metal model. The Chicago Molded Products Corp., Chicago, did the molding job, using Bakelite.

GRINDER BECOMES VERSATILE

OBBYISTS and lovers of fine tools who are fortunate enough to own a DeLuxe Handee, made by Chicago Wheel and Manufacturing Company and described in these pages some months ago, may now purchase a number of accessories to make it into a



Hand grinder in a drill press

far more versatile tool. An accompanying photograph shows a simple mounting which turns it into a drill press. Other simple attachments, or rather, holders, convert it into a router and shaper. The Handee Workshop is a kit which makes possible its use as anyone of 12 machines; lathe drill press, router, grinder, polisher, sander, saw, shaper, and so on

SONIC SOFT CURD MILK

THE Submarine Signal Company has specialized for years in the development of electro-mechanical vibrational apparatus of all sorts. One interesting product of this work has been the development of a method and equipment for introducing soft curd characteristics into milk by the application of sonic energy. Sonic energy-high frequency vibrations and its effect on the



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The Vito Belt is made in several styles. The one illustrated is of pure Para rubber, moided to give maximum support. Hundreds of tiny perforations allow air to penetrate to the skin surface, keeping it cool and halping to evaporate the body moisture. The special lace back permits you to adjust the belt to take care of any change in your size and at the same time give you the needed support.

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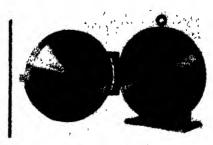
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H. G. CISIN, Chief Engineer ALLIED ENGINEERING INSTITUTE Dept. SA-1 78 Park Place, New York, N. Y.

subject of considerable research by Dr. Leslie W Chambers.

Ordinary cow's milk is assimilated with difficulty by many adults as well as children, due to the large, tough curds formed in the stomach by the initial reaction between the ingested milk and the stomach juices. The necessity for some effective and inexpensive treatment by which the curd formation can be altered to a more easily digested form is shown by the universal practice of modifying cow's milk by various expedients, before feeding it to infants, so as to give a more readily digested curd.

The apparatus used to apply the present process to milk consists of a stainless-steel



Two-foot stainless-steel diaphragm set-up for the sonic treatment of milk

diaphragin approximately two feet in diameter which is vibrated electromagnetically at a frequency of 360 vibrations per second. A stainless-steel cover is provided, as shown in the photograph, which can be bolted against the diaphragm, thus forming a chamber. The milk to be treated is introduced into this chamber through the inlet opening at the outer edge of the cover and in order to pass out of this chamber must of necessity flow over the center of the diaphragm where it is subjected to intense vibration before passing out through the centrally located outlet opening in the cover. The unit shown is capable of handling milk at the rate of 250 gallons per hour with a power consumption of approximately five horsepower.

Curd formation in the stomach as a result of this process is uniformly small and readily digested. During the process the cream in the milk is distributed through it so that no cream line forms on the top of the bottle. It is interesting to note in this connection, however, that although the butter fat particles are distributed through the milk by the process the particles are nevertheless large enough so that subsequent recovery of the cream from returned milk is readily possible by passing it through the ordinary type of separator.

Feeding tests on children and invalids who previously had difficulty in assimilating ordinary milk have demonstrated that the process definitely increases the digestibility of the milk without addition to or subtraction from the ordinary constituents of normal whole milk.

RUBBER TROLLEY GUARD -Safety for Mines

THE exposed trolley wire has long been A a danger to workmen in those mines where electric transportation is used in the main entries. Even when the greatest care is taken to prevent body contact with the wire, there is always the possibility of serious injury or death occurring to a miner due to

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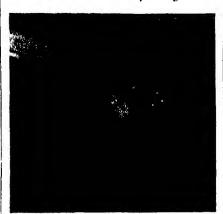
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Trolley wire guards of wood or old fire hose have been used, but both offer disadvantages. Too often the wood guards are made from old or inferior grades of lumber and are easily broken. Use of old fire hose as a wire guard offers an advantage in that it is flexible. However, it does not offer perfect protection due to the fact that the yarn in such hose acts as a conductor of electricity.

A solution to this problem is offered by The B. F. Goodrich Company, in the development of a new rubber trolley wire guard de-



No more shocks from mine wires

signed especially for mine service. This guard is made of cloth-inserted sheet rubber, 3 32 of an meh thick by 9 inches wide, which "U" shape It provides complete protection s folded double and cured in a permanent for the workmen because the material flexes or bends in either direction. Installation is simple and economical. All that is necessary is to notch the rubber guard to fit around the trolley wire support and place it over the wire like a saddle.

MAN STILL CHAMPION OF THE AIR

DIGRESSING for the moment from the usual types of scientific investigations which ordinarily occupy his time, an industrial research scientist has exploded-with proofs aplenty in different ways-a fantastic yarn about an insect that flies so fast that it arrives before you hear it leave-a fly with a speed of 818 miles an hour (sound travels only 740 miles an hour).

The scientist is Dr. Irving Langmuir, associate director of General Electric's research laboratory and Nobel prize winner, the fly whose reputation he has smashed is the deer bot fly, which repeatedly in recent years -and more and more as time has progressed-has been held up as something which has far outstripped man's puny efforts to become flight-speed champion of the living world. Man's fastest planes hurl themselves through the heavens at a mere rate of hardly more than 400 miles per hour.

Particularly in recent months have there been cartoons and news items referring to the speedy deer bot-fly or again simply to the

Now Dr. Langmuir has shown:

1. The non-streamlined-and really flatheaded—fly at such a speed would encoun ter a wind pressure against his head of about eight pounds per square inch, probably enough to crush him. R=pd2v2f is his proof.

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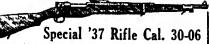
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velocity of 818 miles per hour would be about one half horsepower which, for a fly, would be a good deal.

3. If the fly equals man in efficiency—and it doesn't seem as though the fly can be more efficient than man who as an organism himself has a high thermodynamic efficiency—the fly must consume 1.5 times his own weight of food each second to deliver the 370 watts, or nearly half horsepower of energy, which such speed requires.

4. A piece of solder of roughly the dimensions of the fly can be seen only as a blur if, in a brightly-lighted, white-ceilinged room it is attached to a silk thread and swung so that its speed is 13 miles per hour; at 26 miles per hour it is barely visible; at 43 miles per hour it appears only as a faint line and its direction of flight cannot be told; and at 64 miles per hour the solder "fly" is invisible. (The higher speed attributed to the fly was based on a published report of an entomologist that he had seen the insects fly past him so fast that they could be seen a blur, and that he estimated their speed as 400 yards a second, or 818 miles per hour.)

5 Laboratory light intensity measurements and calculations also prove that an object the size of the deer fly is invisible at speeds of 64 miles per hour and above.

6. A fly striking a person at such a speed would exert a force of 310 pounds, or about four tons per square inch, and would penetrate deeply into human flesh—and the first such instance is yet to be reported, and finally,

7. Dr Langmur concludes a speed of 25 miles per hour is a reasonable one for the deer fly, while 800 miles per hour is utterly impossible.

Aviators, then, do not have to hang their heads in shame because they can hardly surpass 400 miles per hour with today's airplanes. Nor will they ever have to move over in their courses to give the right-of-way to deer-fly speedsters.

LARGEST

THE largest steam locomotives in the world are in operation in the United States. The boiler barrel of one of these locomotives, if all tubes and other obstructions were removed, is large enough to permit any standard automobile to be driven through with room to spare.

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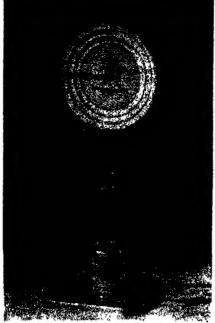
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DEW PONDS AGAIN

PREHISTORIC Britons, confined to waterless hillsides by wolves on the plains, obtained water for their cattle by constructing mysterious dew ponds. Slightly below the crest of a hill, a shallow pit was dug and lined with straw; a layer of puddled clay was added, and gradually a pond appeared, filled with water from an invisible source. Day after day the herds drank, yet



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the ponds remained filled, fed by moisture condensed from the air.

Modern scientists are not yet certain why dew ponds work so well, nor do engineers know the conditions necessary for duplication elsewhere. Natives say that the only known successful builders today are from a single English family who use inherited methods, except that concrete replaces clay. The bed of chalk running from the Weald of Kent through the Sussex Downs to Wiltshire is the only subsoil known to support these ponds. Whether the chalk is essential no one knows. George and A. J. Hubbard. British scientists, once wrote an able and fascinating treatise on the subject, but they were unable to duplicate the results.

Obviously a dew pond must condense more water than it evaporates, which means that it must keep cool. It must lose heat otherwise than by evaporation, and must not absorb heat unnecessarily from the earth Recent research has shown that water is nearly perfect as a "black body" or a body that easily gives off heat by radiation. and this discovery may furnish one key to the dew pond's efficiency. The balance is delicate and the straw which keeps away the heat of the earth must be kept dry. The flint men protected their straw insulation earefully against moisture, and 20th Century man suffers by comparison when he finds ite between clapboard and plaster in his insulated home. To the men of the hill, such ignorance of nature's ways meant victory for the wolf pack.

Nearly 3000 years have passed since the Neolithic hill-man fought off wolves with organized trench warfare, defending his herds and his temples of the sun "Trolls, kelpies . . . pixies, gnomes and the rest-gone, all gone!" But dew ponds remain to intrigue and mystify the sages of a modern day - The Industrial Bulletin of Arthur D. Little, Inc.

THE CHINESE ARE NOT RACIALLY ALIKE

R. Chungsee H. Liu has attempted a VI classification of the races of China in which he points out that the Chinese people are by no means a homogeneous unit, as commonly supposed, and examines critically the classifications of those anthropologists who have recognized this fact. Mongol, Mongo loid, and Mongolian, are loose and unsatisfactory terms, and Homo sinicus is suggested to replace them

In the Chinese population as a whole, the physical characters are, in general terms: hair miversally black, lank or coarse. straight, with almost circular cross-section. body and face hair very scanty, skin varying from yellowish to yellow-brown; eye color light-brown; setting of eyes horizontal or oblique with epicanthic fold; cheek bones prominent; medium to broad-headed; nose relatively flat with depressed nasal bones; medium stature; slender or thick-set; hands and feet small.

Jan 30

Hadden's

Within this general description, three types are recognized, which are distributed in accordance with the three great river-systems of China: (1) The Huangho type in the north, mainly found in the valleys of the Huangho, the Liao Ho, and the Sungari Rivers in Manchuria. This type is of high stature, long-headed, slender-nosed, and of

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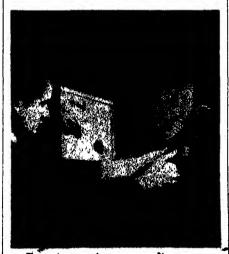
vigorous physique and robust feature. It is honest and frugal, slow but sure, chivalrous and conservative. The people speak the northern Chinese mandarin, and may be regarded as the archaic type of Chinese. (2) The Changkiang type, mostly confined to the Chang Kiang or Yangtze River valley in a favorable natural environment. This type is of medium stature, of medium head width and medium nose height, with light yellowish complexion. The people exhibit great iterary power and ability. They speak southern Chinese mandarın with local dialccts-the progressive type of the Chinese nation. (3) The Chukiang type in the Chu Kiang or Pearl River valley of southern China, with Fukien as an eastern corridor and Hainan Island beyond the sea They are of shorter stature, broad-headed, low-nosed, of darker skin color, Mentally this type is vivacious, and adventurous, quick in action and radical in thought. They speak various dialects of southern China-Adapted from Nature (London)

NEW INSECTICIDES

BRITISH research on chemicals for the control of pests has recently revealed the fact that several unusual compounds ordinarily used for other purposes possess merit for controlling insects Tetramethylthiuram sulfide, a valuable accelerator in rubber vulcanization, repels the Japanese beetle. Methyl bromide has been found to be even more toxic than hydrocyanic acid for several types of moths and larvae and is being used effectively against granary weevils Phenol thiszine is being studied as a substitute for lead arsenate. Dichloroethyl. ether, used as a solvent in refining petroleum, has been found effective in killing the wire worm.-D. H. K

Homing Pigeons EXPOSED TO RADIO FREQUENCY WAVES

CCASIONAL reports have appeared from time to time to the effect that radio waves disturb the homing instinct of homing pigeons. One of these reports covers tests conducted by the Navy Department at Lakehurst, New Jersey, and shows quite conclusively that the pigeons were affected. Those exposed to radio waves at the antenna of the A. T. & T transmitter at Ocean Gate, New Jersey, took much longer to return



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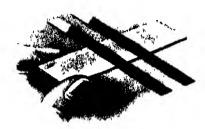
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Table of Contents Chemistry of Plant Life Growing in Mineral Aggregates, Sand-Culture Method, Subtrigation Method Growing in Water, Walter-culture System, Nutrient Solutions. Household Plant Culture Growing Flowers for the Family Growing Vegetables for the Familty Commercial Aspects Special Chemicals, Plant Hormones, Doubling Chromosomes in Plants, Effects of Miacellaneous Chemicals on Plants Common Detriments, Nutlent Formulas, Index Common Detriments, Nutlent Formulas, Index

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home than did those birds released at the same location but not exposed.

In order to find out, if possible, what were the effects of radio waves on pigeons, a 190watt oscillator was constructed in the laboratories of the Zenith Radio Corporation under the supervision of Commander E. F. McDonald, Jr., the organization's president, and a series of experiments were conducted at many different wavelengths on homing pigeons. The oscillator was arranged to have large tank coils so that the pigeons could be placed in a strong field. The oscillator was adjustable over a range of five to 50 meters.

The pigeons were released one at a time at suitable intervals. The tests were carefully arranged so that only certain pigeons were exposed to radio frequencies. The remainder were kept 1/2 mile away from the oscillator, mside a steel bodied truck.

Tests were conducted under these conditions at Mount Prospect, Illinois, beginning October 13 and continuing through October 27, with the following results.

EXPOSED TO RADIO FREQUENCY

H'at	elength	No of Prace is	Fl_{λ}	ng Time Inutes
7	Meters	1		35
11.5	••	3		24
15	**	4		27
20	••	5		27
311	**	3		31
40	•	4		32
50		3		28
Average T	ime		29 1/2	Minutes

NOT EXPOSED TO RADIO FREQUENCY

No of	Flying Time
Procons	Minutes
2	24 1.,
9	241
3	30
2	23
3	37
<u> </u>	24
3	21

Average Time

2614 Minutes

Flight course 25 6 Miles About 125 pigeons flown during entire tests Above compilation covers 40 pigeons

It appears from these figures that homing pigeons exposed to radio frequencies are affected by the exposure and that in some way their ability to return home does slow up The difference in time used to return home between the exposed and the unexposed birds is not very great; however, it must be borne in mind that the power of the oscillator is not great. Considering this, the results obtained become significant.

During the course of these experiments many other tests were conducted. In some cases fixed permanent magnets were hung around the necks of pigeons. This was done to determine whether or not the pigeon's homing instinct might not result from some ability on its part to be guided by the earth's magnetic lines of force or, as has been suggested, since there exist no two places on the earth's surface having the same magnetic field strength, these birds might seek that field strength which exists at the home lofts. It was found that the magnet on the pigeon's neck did not seem to affect his homing ability at all. Further tests of this type might produce more conclusive evidence. However, the present tests indicate that the flying time is the same both with and without the magnet.

It has been reported that homing pigeons having their ears blocked up fail to return to the home loft. The use of wax in the ears seems greatly to irritate the pigeon. In order to make this test under conditions where the pigeon would not be irritated in any

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way and would be normal in every respect, except that his hearing would be stopped, the ears were completely filled with Vaseline. The feathers all around and over the cars were also smeared with Vaseline. The temperature on the day of the tests was around 45 degrees and the Vaseline quite solid at this temperature. The pigeon so treated returned home faster than it had ever been known to do so before, and with the Vaseline still in its cars. It is possible that further tests might develop additional information; the fact that the pigeon returned home in very much faster time is at variance with other reports which indicate that the pigeon loses his homing instruct entirely when his ability to hear is removed.

Several tests were also conducted where an antenna was coupled to the oscillator and a half-wave antenna, of very small wire, tuned to the transmitter frequency, was tied to the pigeon's leg so that there was actual contact to the leg. This seemed to slow the bird's flight up somewhat and it is difficult to say whether the slowing up was due to the drag of the antenna or the resultant application of more radio frequency to the pigeon through the medium of the antenna

This test would be of real merit in the vicinity of a regular transmitter having considerable power.

The facts produced from the experiments would indicate that the pigeon's organs of hearing apparently are not connected with the homing instinct is not affected by magnetic fields such as the earth's field, that radio radiations do affect the homing instinct, and that the homing instinct is not appreciably affected by any particular wavelength in the short wavelength ranges, any wavelength producing about the same results.

It is of interest to note that exposure to radio frequencies in the ranges tested, often seemed to make the pigeon restless and that at 20 meters the respiration and heartbeat seemed to increase a noticeable degree and to an extent much more noticeable than at any other wavelength in the range used.—C. E. Brown, Zenith Radio Corporation

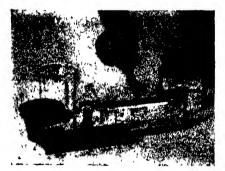
RADIUM HOUNDS

(Continued from page 8)

suspected thief, as well as all likely caches, could be searched entirely without his knowledge. Even his home could be thoroughly "ransacked" by the unobtrusive method of parking a car carrying a Geiger-Müller counter in front of it.

With the increasing use of radium in "radium medicine, the manufacture of hounds" is on the rise. About 20 of these devices are now being used in the United States. Some of them are home-made affairs, but at least two companies manufacture them for the trade, at an approximate cost of \$125. Are the machines effective? Of the 107 radium losses mentioned above, 59 complete recoveries and 11 partial recoveries were made by "radium hounds." The radium thus recovered represents several hundred thousand dollars in cash, also the removal of a grave potential hazard to any human being who might unconsciously come in contact with this burning element. Since the advent of the "radium hound," I know of no instance in which anyone has been serienaly injured by lost or misplaced radium.

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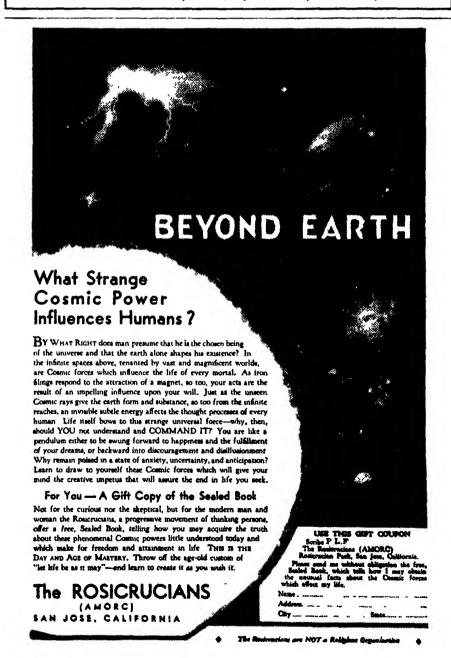


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PICTURE-MAKING BY ENLARGEMENT

TIME was when the contact print wa-L taken for granted and only the so-called 'advanced" amateur and professional went in for enlarging his pictures. But with the advent of the miniature negative, the enlarging camera became essential equipment A great many amateurs today use an enlarger as a matter of course not only because the numature negatives most of them make cannot be seen properly in a contact print



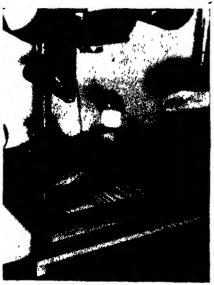
Courtray Federal Stamping & Eng Corp Focusing the enlarger

but chiefly because of the many opportunities afforded by the enlarging medium for improving the final result

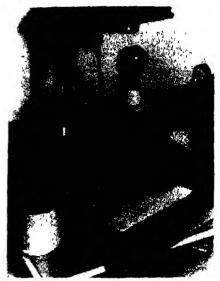
Undoubtedly the chief attraction of the cularging medium in photography is the large print The mere comparison of a small contact print with a 5 by 7 or 8 by 10 enlargement of the same negative image is enough to sell the enlarging idea to practically any photographic worker. But more wonderful even than this is the remarkable fact that by the same token and in the same way that the negative is enlarged to greater proportions, a mere portion of the negative may be selected and magnified to occupy the full format of a good-size print. The opportunities thus afforded for recomposing the arrangement of the negative image, for altering the emphasis of certain details, for introducing a special meaning that may not have been perceived in the original subject as recorded on the negative, are all too obvious to require more than mention. Moreover, it is no mean advantage thus to be able to delete extraneous matter, particularly when the focal length of the lens or an enforced vantage point made it necessary to include more than was actually wanted

Control in printing, more familiarly known as "dodging," is practised most effectively during enlargement. Suppose, for example, you project on the easel a negative image in which the shadow detail is abnormally lower in the tonal scale than the detail in the brightest highlights. For the best possible enlargement from this negative, you will want to show detail in both highlights and shadows. If you were to expose for the highlights you would lose or badly damage your shadow detail, and if you exposed for the latter, your highlights would very likely show little more than white paper. In order to get both shadow and highlight detail in an enlargement from the negative mentioned, you will have to resort to the procedure known as dodging This is done by attaching a piece of cardboard or wad of cotton to the end of a wire which is held in suspension for the required time between lens and easel. The dodger is cut or shaped to the required size and form and agitated during the exposure In this manner, relatively transparent or thin areas are held back, relatively dark or dense areas are permitted a longer print ing time by the use of a cardboard large enough to more than cover the size of the paper on which the print is being made and with a hole cut in it so positioned and of such a size as to permit the dense area to pass through while the rest of the negative is completely shaded

Another interesting printing method is that of the photomontage made by projecting a number of different negative images



Dodging



For photomontage work

on the same sheet of paper. As each image is projected in its allotted space on the paper, the rest of the paper is shaded, as shown in the illustration or by some similar method. Before actual operations are begun, a plan must, of course, be laid, and the individual negatives projected and spaced off on a plain sheet of paper which, thereafter, becomes the guide for the projected images. Adjoining areas are made to merge into one another and should not show sharp, delimiting lines.

Distortion of the negative image is accomplished during projection by tilting the paper easel in relation to the enlarging camera lens so that the image is either elongated or broadened, depending on the position of the easel with relation to the projected image. Tilted buildings caused by an upward tilt of the camera in making the exposure may be corrected under the enlarging lens by a contrary tilt of the easel, thus bringing the building upright again.

These are the principal uses of the enlarging process and many workers see in them more than their money's worth in the purchase of an enlarging camera

World's Fair Pictures

THE ability to "see" pictures is rarely so well demonstrated as in the work of Richard Wurts, of New York City, a widely known photographer, who recently exhibited more than 50 pictures of the New York World's Fair in the making. Held at the Museum of the City of New York, the display marked Mr. Wurts' first one-man show and well deserved the wide attention it received. Those photographically minded were impressed with the implied proof so graphically displayed that picture materials may be found in relatively unpromising surroundings provided the photographer has "what it takes" to pick them out.

When asked why he had taken the trouble to make pictures of subject-matter that was merely preliminary to the real and completed thing, Mr. Wurts explained that primarily what he was interested in was not so much the identity of the subject-matter itself as the opportunity it afforded for obtaining striking pictorial effects. Incidental to this but none the less worthy of the efforts he had expended in shooting the pictures was the documentary or historical aspect

LAST CALL

For Entries in the Third Annual SCIENTIFIC AMERICAN Photography Contest

All entries must be in the hands of the judges by January 2, 1939

Complete Rules in October 1938
Scientific American

of the pictures which, once the Fair construction was completed, could never be made again. One of Mr. Wurts' World's Fair photographs appears on the front cover of this issue and another on page 24

NEW SCHEINER RATINGS

THE announcement that Kodak Super XX, introduced in the 35-mm size, is now available in all the popular roll-film sizes and in film packs, is accompanied by Scheiner or Photoscop ratings for the new Eastman films. These ratings, which supplement those for the Weston and General Flectric systems announced in a recent issue of this department, are as follows

	Daylight	Mazda light
Panatomic X	25	23
Plus X	26	24
Super XX	29	27

These ratings are intended for average exposures and are not intended to be the maximum speeds. Negatives made with half the exposures called for will be quite satisfactory under ordinary conditions, but where the subject includes much shadow detail, for example, it is not always wise to attempt the shorter exposures. As a general, practical guide, the speeds indicated will result in fully exposed negatives.

Y.M.C.A. CAMERA CONTESI

YOUTH holds the limelight in an international photographic contest under the auspices of the National Council of the Young Men's Christian Association of the United States. The contest, which closes February 15, 1939, is open to amateur photographers throughout the world. Winning photographes will be used in the decorative scheme of the Young Men's Christian Association Building now being erected on the World's Fair Grounds in New York City

Submitted photographs must picture the life and activities of present-day youth in the five following classifications: Youth at home; Youth at work, Youth at play; Youth and citizenship, and Youth at worship. There is a first prize of \$25 and a second prize of \$15 m each group, with an additional grand prize of \$50 for the best photograph in the entire contest.

Contest rules limit entries to work of amateurs, require that pictures must fit one of the given classifications, and that prints must not be smaller than 8 by 10 inches, black and white. All entries must be in the hands of the Photograph Contest

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From 1 by $1\frac{1}{2}$ to 64 by 50

PHOTOGRAPHIC enlargement 64 A inches high and 50 inches wide made from a mere 35-mm negative and showing an Indian chief will soon become a familiar figure throughout the country as the Zeiss exhibits make their rounds. The negative 18 the work of Frank H. Shearer, of Bay City, Michigan, who writes that the negative shows "no perceptible grain" when blown up to these dimensions, "and every detail is perfect." He adds that no "step up" process was used, that is, no intermediate negative, and that the enlargement was made directly from the original 35-mm negative on paper 50 inches wide, not pieced together Mr. Shearer gives the following data. Exposure in Contax III, equipped with Sonnar f/2, at f/4 and 1/125 second Film used was Eastman Panatomic and development was in MPC

HUNTING WITH FLASH Guns

THE Craighead brothers, Frank and John, who have been doing some notable work in the field of wild bird photography, pay tribute to the range finder and the flash gun for having made possible some unusual shots which they say could not otherwise have been obtained. Among the pictures which they have made are the two which they kindly permitted us to reproduce here Concerning one of these they write.

'This represents an osprey or fish hawk leaving a fence post with a fish in his right talon. This picture illustrates how he uses one foot to shove off with and the other to grasp his prev. A few seconds later he will clutch the fish with both talons. Our Kalart



"Good Pishing"

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Amateur Photographers

New Ways in Photocaaphy, by Jacob Deschin. Eminently practical from every point of view, this new book contains nothing of theory and nothing that the advanced amateur photographer will not find valuable in one way or another. It covers the whole range of amateur photography, discussing such things as trick pho-tography, photomurals, retouching, infra-red, and a number of other subdivisions that will not be found elsewhere in as clear and concise a monner. \$2.90.

INFRA-RED PHOTOGRAPHY, by S. O. Rawlings. A treatise on the use of photographic plates and films sensitive to infra-red. Exposure and processing are fully covered; formulas are given for sensitizing. \$1.65.

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CHAMPLIN ON FINE GRAIN, by Harry Champlin, A complete hand-book on the entire subject of fine grain, including formulas and how to compound and use them. \$1.90.

PHOTOGRAPHIC HINTS AND GADGETS, by Fraprie and Jordan. How to make all kinds of photographic accessories from film clips to cameras to lighting equipment, and so on; 250 articles and nearly 500 illustrations. \$3.70.

ELEMENTARY PHOTOGRAPHY, by Neb-lette, Brehm, and Priest. You can learn much of the fundamentals of photography from this little book even though you have little or no knowledge of physics and chemistry.

PHOTOGRAPHIC ENLARGING, by Franklin I. Jordan, F. R. P. S. One of the most interesting and authentic books on enlarging. Its 224 pages cover every phase of the subject and 75 illustrations, many of them salonwinners, show the value of correct technique. \$3.70.

PORTRAIT PHOTOGRAPHY, by H. Williams. Fundamental principles of composition and lighting, paving the way to satisfactory results in this particular branch of photography.

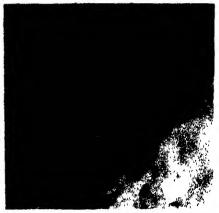
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focusing device made this picture possible,

for quick focusing was essential.
"The other picture," they continue, "was taken with the aid of both the focusing device and the synchronized flash. It represents a young great horned owl in its nest The nest was located in a small cave on the side of a cliff. The picture was taken as the young owl raised his wings in alarm. Even with the fastest film, it would have been impossible to get the picture without a synchronized flash. The great horned owl is one of the largest and fiercest of our owls, usually nesting in large wooded tracts far from the habitation of man."

CAMARADERIE OF THE

CAMERA

VHE camera has become the passport to Impromptu friendships to such an extent that it needs no more than the display of one's camera in park or street or aboard ship to strike up an acquaintance with any other camera toter in sight. This has happened to this department on several occasions. We would be poking the camera up at some building or other and before we had finished, someone would come up and want to know what stop and shutter speed were used, what film, what filter, and so on In no time at all the two would be talking on camera subjects in general with the freedom one usually employs with a friend of long standing This unfailing "open sesame" to acquaintanceships that characterizes the camera fraternity led this department to invent a new term, namely, "cameramour," and the camera user as "cameramorist" Camera love and camera lover seem a bit far-fetched when heard for the hrst time But how about bibliophile? Persons who collect first editions of books think this term to be quite proper and aptly descriptive of the book collector.

STANDARDIZING

PHOTOGRAPHY

S TANDARDIZATION in the field of photography took another step forward recently with the appointment of a new committee on standardization, according to an announcement by the American Standards Association, of New York City. Initiated at the request of the International Standards Association, the new committee will represent 40 different organizations, including Federal government departments, user graupa, manufacturers of photographic

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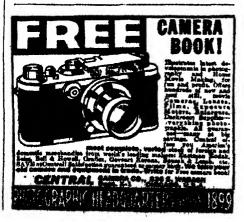
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JACOB DESCHIN, conductor of our "Camera Angles" department, will answer in these columns questions of general interest to amateur photographers. If an answer is desired by mail, enclose a stamped, addressed envelope. Queries should be specific, but Mr. Deschin cannot undertake to draw comparisons between manufactured products nor to advise on the purchase of equipment or materials—The Editor.

Q. I am interested in making my miniature films into positives for projection. I understand there is a special formula used. There is a way to make lantern slides, but I wish to develop the film as motion picture film is developed. Would you tell me the formula and process of development?—W. R.

A. The better method of obtaining positives from your miniature negatives is to print on positive film and use the latter for projection. However, here is one good reversal process that may be employed in this connection. Several others are given in the "Universal Photo Almanac and Market Guide."

Soak the film in water at 65 to 70 degrees, Fahrenheit, for one minute and follow this by development for three to five minutes until all highlights in the negative image are as dark on the back side of the film as on the emulsion side. This developer is made up of one part of the following stock solution and one part water, temperature in each case being 65 to 70 degrees:

Stock Solution

Water (at 125°)	l gallon
Metol	180 grains
Hydroquinone	1% ounces
Sodium sulphite (desiccated)	7 ounces
Potassium bromide	⅓ ounce

Add one dram of strong ammonia water to each 16 ounces of working solution.

After development, immerse for three minutes in combination stop and hardening bath made up of one ounce of chrome alum to each 32 ounces of water. For another three minutes bleach the negative image out completely in the following bleach bath.

Water 32 ounces
Potassium bichromate 64 grains
Sulfuric acid (concen. pure) 4 drams
(Note: add the acid to the water, not the

Now wash for three minutes and then clear out stain of the bleach solution in the following clearing bath for 2 minutes:

Turn on the white lights, A general service 160-watt damp, five feet from the film, will be about right. Wesh film for five minutes in running water, or six changes of water. Finally, redevelop film in the same developer used the first time, or any good non-staining M-Q formula, such as DK-50, D-16, or D-72, diluted 1 to 4.

Q. I have heard there is a way of drying glossy prints within a few minutes' time. Can you describe this method?
 S. M.

A. Fill a tray with wood alcohol. Before placing on the ferrotype tin, immerse the thoroughly washed print in the alcohol for one minute. In less than five minutes the prints will peel off the tins, completely dry.

Q. Please list some of the advantages and disadvantages of the "vest pocket" (15%" by 2¼") vs. the square (2¼" by 2½") negative sizes.—L. A. K.

A. The square negative has become very popular largely because of the fact that the camera does not have to be shifted to make vertical shots, as one has to do in the case of the rectangular shaped negatives. Many, however, avoid this shifting by making all shots in the normal position and enlarging to the desired composition. On the other hand, the square negative is disliked by some because most pictures are enlarged to a rectangle, whether vertical or horizontal, and one is inclined to forget and to compose the subject in the view finder or ground glass so that nothing looks right but the square composition. The main answer is, so what? Many pictures are made in the square format and look good that way. There is no law against square pictures and if your picture looks better square than rectangular, go ahead and print it that way.

Q. In comparing the readings afforded by my xxxxxx electric exposure meter with those given, under the same conditions, by an electric meter owned by a friend, I found that my meter called for exposures about twice those indicated by the other meter. Whose readings are correct, mine or his?—D. J. L.

A. Assuming that both meters are in good working order, we offer the opinion that it is not correct scientific procedure to take two meters and compare their readings, condemning any differences that may appear. This is due to the fact that different meters

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calibrated differently, all providing readings that will result in negatives of good density, though differing as to the depth of this density. That is, one will result in a negative of a certain density while another will have a somewhat greater degree of density. The printing results, however, will be about the same. As a matter of fact, due to the great latitude of modern emulsions, it is possible to over- or underexpose to a considerable extent without injuring the printing possibilities of negatives so exposed.

Therefore, it is possible that the readings of both your meter and that of your friend were correct for the subject in question. Also, it must not be overlooked that exposure meter readings are not intended to be the last word concerning exposure, but to perform the services of a guide That is, if you do not like the density provided by the meter reading, all you need to do is to give particular films a higher or a lower rating than that indicated for the particular

Q. What is the proper height for an enlarging table?—M. S.

A The ordinary table height of 30 inches will do, but if you are constructing a table specifically for the purpose, we would suggest reducing this to about 26 or 27 inches This height will be found more convenient for persons of average height. Taller persons on the other hand, may find that a height greater even than 30 inches may be more suitable

Q. Would you please explain the presence of bubbles in my lens, as well as their effect? There seem to be more bubbles in my lens than in other lenses I have seen,-D. L.

A These bubbles are common with all lenses and are unavoidable in the manufacture of lenses. Furthermore, it is of little consequence whether your lens has more bubbles in it than, perhaps, another lens you may compare with it. The bubbles are absolutely transparent and do not affect the clarity or sharpness of the image in the least. The light image passes these bubbles practically without alteration and with the same ease and directness as if the bubbles did not exist

O. How should the condensing lenses be mounted in an enlarger—flat surfaces together, or convex surfaces together? When I make enlargements of about 4 diameters magnification the prints show marks of air bubbles from the condenser lenses, and also a dim shadow from one side of the bulb I use for enlarging (a 75-watt frosted Maz-With greater magnifications around 7 diameters, these defects are not noticeable in the prints .- K. L. R.

A Answering your first question, condensing lenses are mounted with convex surfaces facing each other but not in contact The result of mounting these lenses in this fashion is to concentrate the light rays, make them converge, whereas the opposite would be the effect were the lenses mounted with flat surfaces against each other. It is not possible that the air bubbles will appear as marks on the prints for the reasons outlined in our reply to D. L. elsewhere in this department. More likely, the marks you refer to are caused by lint or dirt

on the condenser. Clean your condenser lenses carefully, as well as the surfaces of the negatives, and observe the difference. The shadow you refer to is doubtless due to the fact that the enlarging light is not properly centered, an absolute essential for obtaining an even disk of illumination over the negative area.

Q. In focusing on the ground glass of my miniature single-lens reflex camera, the smaller the stop the more difficult the alignment becomes. I would appreciate it if you could help me with some suggestion.—D. W.

A. Here is an idea that has been tried out with success by a man who uses one of these miniature reflex cameras in photographing architectural details on buildings You know those transparent rulers they sell at the five-and-ten-cent store? This man cut a piece from one of these rulers about a half inch square and glued it in the center of the ground glass. The thin criss-cross lines are a great help in alignment, particularly when the lens diaphragm is stopped down or where the light is poor and focus ing is difficult even at the larger stops

O. I wish to construct a depth-of-field table for my camera lens with the help of the instructions given by you in the July, 1938, issue. My camera is an Agfa Isolar, 9 by 12 cm size. Its lens is f/4.5and is marked as equivalent to 13.5 cm in focal length. I think I should be able to prepare the required table by following your suggestions in the July issue provided I know the circle of confusion. I would like to know how this is determined.-C. R.

A In our reply to P. P. A. in the September, 1938, issue, we attempted to explain this subject and if you have not seen this, perhaps reference to it may help you to understand the matter a little better. Generally speaking, the diameter of the circle of confusion which one elects to employ in figuring out a depth-of field table for a particular lens depends on two things, the distance from which the picture is to be viewed and the degree of enlargement to which the negative is to be subjected. The greater the distance from which the picture is to be viewed or the smaller the enlargement of the negative, the larger, relatively, is the permissible circle of confusion. The reverse, however, obtains when the viewing distance is relatively closer or the enlargement is relatively greater. In your particular case, a circle of confusion of 1/250 will be right since 8- by 10- or 11- by 14-inch enlargements are probably the largest you intend to make. if you intend to make any enlargements at all, and a viewing distance of about 10 or 12 inches will be the closest approach.

O. Please advise what can be done to remove the film of moisture or dust that sometimes settles on the mirror of my miniature reflex camera when the lens is removed or changed.-W. P. M.

A. It is our suggestion that when you remove the lens from the camera you take extra precautions against the possibility of dust or moisture entering the camera and settling on the mirror. Once dust has settled on the mirror, however, our best suggestion is that you attempt to remove this dust with a very soft brush or cloth, being careful not to press heavily on the mirror in doing so.

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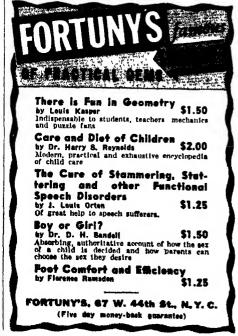
By Brian Curtis, State of California Division of Fish and Game

FOR those fishermen (and others) who have scientific curiosity about things in general and fish in particular this is the book, and it provides evidence that there is a lot more science in one poor fish than some other poor fish who merely fish may realize. What a fish is, body covering, framework, senses and nervous system (some surprises here), air-bladder, internal workings, reproduction, growth, trout and salmon, other game fishes, habits and adaptations-those are the chapter headings and the approach is scientific without being too scientific, and is always friendly, informal, and readable, not pedantic or stuffy. Many common questions such as "Do fish feel pain?" are anwered (260 pages, 51/2 by 8 inches, 38 illustrations)-\$3 10 postpaid -A G I

THE MAGIC WAND OF SCIENCE

By Eugene W Nelson

POPULARIZED science is the keynote of this book, but not in the sense that an attempt is made to sensationalize and play up those aspects of science which approach the borderline of pseudo-science. The author has written particularly for the intelligent layman who has a definite desire to acquire a certain amount of knowledge regarding science, and who does not wish to delve deeply into the background. The text runs the gamut from microscopy to motion pictures, from soy beans to the fourth dimension, from enzymes to lightning; it covers briefly a wide field of interesting things in between. (213 pages, 5½ by 8 inches, 45 illustrations)—\$2 10 postpaid—A. P. P



A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

LUMINIZING one's own telescope mir-A rors is probably uneconomical, considering the time, materials, and cash required to build the rather elaborate appaiatus. On the other hand, the man who rationalizes his decision to build it as "an economy," but is subconsciously simply seeking something that is fun to do, is a real living demonstration of Professor Hale's characterization of the amateur-a man who "works because he cannot help it" He is therefore altogether in order, or better Guy R. Evans, 3007 N. E. Flanders St., Portland, Oregon, submits a description of a vacuum pump he has made and used in connection with Prof. Yeagley's aluminizing equipment described here in July and August, 1937, and he says it "gives better results than I ever thought would be possible" He made this diffusion pump because he did not find that the mechanical pump there recommended gave a good enough vacuum. Here is his description

"The pump, shown in Figure 1, is constructed almost entirely of brass and copper tubing at least 1/18" thick (do not use cast metals). The end pieces for boiler and jet chamber are 3/10" sheet brass The water jacket 5 may be 3/12" brass tubing.

There are two stages in this pump. The first, or jet, stage is in the upper part, and the second, or annular, stage is located just below. The clearance of the first stage jet depends upon the fore vacuum, and should be adjusted to about 1/32". Most oils cool readily, so the heavy-walled copper tube 2 is insulated by a glass tube 10. Tube 2 rests on the bottom of the boiler, and is adjusted by a 1/4" cap screw 1. The jets are shaped in such a way that they will not clog with oil. This has been a serious defect of most oil pumps.

'11 is a pin for removing tube 2. It can he lifted out with a hooked wire.

"9 18 soldered to the tube that comes from the hoiler, and acts as a guide as well as a jet The openings in this jet should have approximately the area of the copper tube.

"A "i" length of tubing is soldered to 9. This centers the glass insulating tube 10, so that when the copper tube is removed, the insulating tube will remain in place

'7 is a glass insulating tube to insulate 8. "The openings marked B serve as passages for the oil vapor to the first stage let

"15 is a copper spinning with a 1/2" hole in its center for the copper tube 2 to pass through. This part of the jet should be accurately centered and soldered in place.

"14 is a trap to let the condensed oil pass back to the boiler without letting the air and vapor through 'this trap resembles the trap on a sink

"13 is a 14" strip of brass that carries the oil to the wall of the pump

"16 is the return tube to the boiler,

"Joints marked A, in boiler and connecting tubes, also 8 and 16, are silver soldered or brazed. Other joints may be soft soldered

"The cover, 6, shown in detail, sets in a seat and is waxed in

"The detail of 8 shows a section of the

top of the boiler, also the tube that connects the boiler with the jet chamber. This piece, also the ends for the boiler, jet chamber and water jacket, should be turned in a lathe

"5 is the water jacket that surrounds the jet chamber. It has two short lengths of 1/4" pipe. The water intake should be at the bottom, to prevent trapping.

"The boiler is made of telescope tubing slid into the outer casing. All joints in the

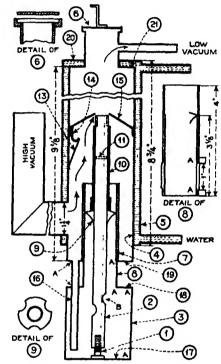


Figure 1. Vertical section of pump

boiler should be silver soldered and then turned in a lathe, so that it can be slid into

"When you have completed the pump, connect to a Cenco-Hyvac or equivalent Make as short connections as possible, especially from oil pump to vacuum chamber. Fill boiler about half full of Apiezon oil 'B'. Place cover on pump and seal with wax. Dr. Strong's mixture, as described in 'ATMA' is O.K. Start the fore pump and scout for leaks. If none is present you should have a high enough vacuum in 15 minutes (using a 9" bell) to start the diffusion pump.

"Heat may be applied to the boiler by a hunsen burner or electric plate. Care should be taken not to overheat. You can tell when the pump is too hot by placing your hand on the high vacuum pipe that goes to the bell, this pipe should be just warm about 3" from the pump. In a short time you will notice the discharge rapidly getting lighter (for this pump works rather fast), until it finally goes out with a clean-up voltage of about 10,000 or 12,000 volts. A neon sign transformer may be used. Let the pump run for 10 or 15 minutes longer, to be sure the vacuum is O.K. Then fire your aluminum. When the coat is thick enough, turn the heat off, but do not stop the fore pump until

the diffusion pump has cooled enough to let the oil condense. Then shut down the fore pump and open the air valve to the vacuum chamber. The articles in the July and August, 1937, issues of the Scientific American take you through these steps very thoroughly.

"With this set-up I have aluminized in 17 minutes, although I generally allow 30 minutes. The resulting coats are beautiful-far better than any silvering I have ever done.

"List of materials:

12" of 21/2" inside diameter brass tubing 1/10" thick or thicker

9" of 3" inside diameter brass tubing 1/32" thick for water jacket.

12" of 1¼" inside diameter brass tubing 1/16" thick.

1" of %" inside diameter brass tubing 1/2" thick.

About 11/2" of 11/4" diameter cold rolled brass for 2nd stage jet.

31/2" of 1/4" inside diameter copper tubing. 9" of 1/2" outside diameter copper tubing. I short piece of copper tubing 1/4" inside diameter for 14.

Enough sheet brass "10" thick, for ends of boiler, jet chambers, 17, 18, 19, 20, and

Enough sheet copper 1/32" thick to complete first jet.

1 ¼" by 1" cap-screw. 3½" of ½" inside diameter glass tube for 10,

3" of 11%" inside diameter glass tube for 7. "The Apiezon oil can be obtained from the J. G. Biddle Co., Philadelphia, Pa."

THE above description was submitted to Dr. John Strong, who suggested that the reader also see the Review of Scientific Instruments, Vol. 6 (1935), page 66, describing a similar pump, and the same, page 75, describing another approved design. He mentioned that a good up-jet design that is simple to build would soon appear in a book he was writing. He found some minor faults with Evans' pump, just described, but, on the whole, commended his enterprise. This book, "Procedures in Experimental Physics," has subsequently appeared and it contains a 57-page chapter on the technique of high vacuum, with another chapter on evaporating. These cover this subject of aluminizing with more thoroughness than anything thus far made available anywhere, and in a wholly practical manner; in fact, anyone contemplating the construction of an aluminizing apparatus would probably miss more tricks than one if he did not first learn what is in this new book by the leading authority on this work.

N the September number F. M. Garland. L of Pittsburgh, told how he made a strain tester for glass, using a lamp in a box, a ground glass screen and polarizing eyeglasses. Just after we inserted that note we espied an advertisement for the kind of equipment which the Polaroid Corporation makes up as a stock product for inspecting glass containers, tubing, tableware, and so on-that is, doing essentially the same thing

as Garland-and asked them for a photo. This is reproduced in Figure 2, merely to show how the professional makes up the same general elements into a stock product. In their reply, the Polaroid people referred to Garland's rig as "ingenious." They also sent a sample of Polaroid Type I for reducing the apparent brightness of the night sky. "The light from city lamps reflected from particles in the air is often so strongly polarized," they state, "that our friends from Harvard tell us it is possible to get rid of a great deal of this light by making the observation through Polaroid, rotating the



Figure 2: Commercial strain tester

Polaroid till the darkest condition is obtained. This reduces the intensity of the celestial object but it reduces the stray illumination to a very much greater degree and so increases the contrast.'

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Of D. O. Hendrix, Mt. Wilson optical shops: Coal tar pitch, melting point 170, 2 lbs., Mefford Chemical Co., 1026 Santa Fe Ave., Los Angeles, Calif. Pine tar oil (drug store), amount depending on hardness of the pitch; start with 2 liquid oz. and increase judiciously toward 4 oz., if needed in order to bring to desired hardness. To these add 11/2 oz. beeswax. In addition, the lap is given a thin coating of beeswax, not alone to eliminate sleeks and scratches due to grit but to reduce polishing friction. Prof. John Strong, in his book "Procedures in Laboratory Physics," mentioned above, includes a 60page account of Hendrix' methods of working optical surfaces, which will intrigue advanced workers. We amateurs are plainly not so far behind, but there are things we

of M. H. Brown, optical shops of the California Institute of Technology, for general use, including work on the 200" mirror: Resin, 1000 grams (about 2 lbs.). S. A. E. Penn Oil No. 30, 4 oz. paraffin, amount depending on need; start with 75 grams (about 2½ oz.) and increase judiciously toward 150 grams. Do not paint the paraffin on top.

As the reader will readily understand, so much special work engages the attention of these two men at present, pressing for com-pletion on schedule, that, against their inclinations, they will hardly find it possible to answer inquiries such as persons mentioned in these columns usually receive in considerable numbers.

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THE BEGINNER'S CORNER

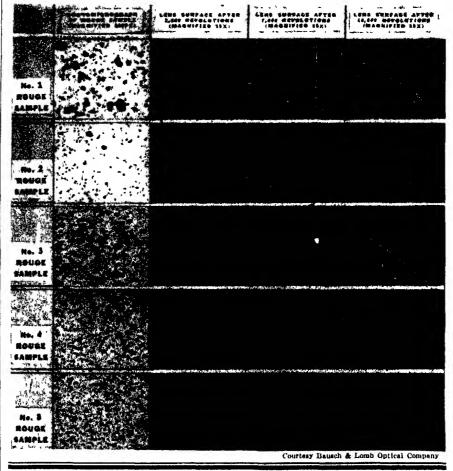
S OMETIMES the unsuspecting tyro telescope maker endeavors to economize by purchasing low-priced rouge. Some have even used jeweler's rouge from their local shops Trouble often followed, which the beginner, without previous experience by which to judge, regarded as unavoidable. There is rouge, and rouge; yes, there is even rouge and rouge, and rouge Polishing silverware (jeweler's rouge) doesn't require anything fancy-thus would be just a waste of money. Polishing eyeglasses requires much better but not the finest; the latter would therefore he a needless expense. Third standard of work, precision optics (including telescope work) requires real Rolls-Rovce rouge, but even that grade is inexpensive

The photomicrographs shown below tell us something about rouge, and rouge, and rouge. Each horizontal row reveals the magnified surface of a lens which has rotated on a spindle under a different grade of rouge. This is machine work, it is true, but the findings apply equally to the amateur's hand work. Top row shows a rouge that would be very decidedly unsatisfactory. Each row below shows a better grade and the effects thereof. Only No. 5 (B. and L. 358-52738) is suitable for precision work.

Now you have an idea, thanks to these high magnification close-ups, about the great differences between rouges. Yet they all look alike when seen at the bottom of the parcel they come in.

It is worth while to go back and study the same photomicrographs again by vertical columns, comparing each. In the first column especially, note the bad but increasingly better particle size distribution. Study also the pitting effects of each, in photomicrographs to the right (pits shown by little white dots)

As stated in the manual of the telescope making hobby, "Amateur Telescope Making," the particles of rouge are roughly 1 30,000 to 1/50,000 inch in diameter—that is, for good rouge



TELESCOPTICS

((ontinued from preceding page)

In The Journal of the American Ceramic Society, 2525 High Street, Columbus, Ohio, Vol. 20, No. 2, appeared an article entitled "The Scratch-resisting Power of Glass and its Measurement," by James Bailey of the Hamburg, N. Y., firm of Bailey and Shaipe (now the Optical Glass Products, Inc., by the way). The following paragraphs, quoted from this article, throw an interesting sidelight on borosilicate and other glasses, and complement our discussion of

glass, begun in this department last month

"If one piece of glass is scratched by drawing across it the corner of another piece, the contact area is small and the unit pressure is comparatively high. When the corner moves rapidly, the work done in overcoming friction easily generates sufficient heat to raise the temperature of the sliding corner above the softening point of the glass; the sliding corner, moreover, becomes so highly heated that it produces a streak of light readily visible in the dark.

"This heating effect brings into the scratching process a new factor, namely, the fusibility of the moving point. Thus a piece of

quartz glass, though softer than ordinary window glass, will easily produce a long, deeply cracked scratch in a piece of window glass when drawn rapidly across it, because the rubbing corner remains hard at the temperature attained. A glass corner will not scratch the quartz slab under the same conditions because it softens and loses its sharpness almost at once. It is possible, however, to make a deep crack and scratch on the fused quartz with the corner of a piece of window glass by keeping the rubbing velocity at a very low figure, such as one milli-meter per second or less. In this connection, all the common abrasives such as sand, corundum, silicon carbide, and emery have very high melting points, while diamond, the hardest of all, is infusible.

"Grinding experiments show that quartz glass and glass containing large amounts of silica and B.O. are the most difficult to grind The ball test shows that these types are really softer than most other glasses. The reason for this is apparent if a fresh scratch made with a diamond is observed under a microscope. The scratch in quartz glass, once made, undergoes almost no change. The initial fractures do not extend nor does any appreciable amount of material fly out of the scratch. The same applies to a considerable extent in the case of high B.O. glasses. With glasses of the conventional window-glass and bottle types, the initial scratch is small, but pieces begin to fly out of the body of the glass along the sides of the scratch almost at once, and this process continues for a period of several minutes, at the end of which time vastly more glass has been loosened than was initially cracked or apparently injured by the scratch. The ability of a material to resist abrasion, as in grinding, is a measure of its work-absorbing power rather than its true hardness."

NOMOGRAPHS is the name given by their "worker-out," G. W. Gasper, 3245 Woodford Rd., Cincinnati, O, to six 12" blueprint wall charts on each of which a required datum can be found simply by placing a straight edge through two known values inscribed along a line and then looking for its intersection with a third line, hence the term almement charts, also applied to them. For example Given mirror diameter and focal ratio, automatically find accuracy required in parabolization; or given diameter of eyepiece field lens and focal length of objective, find angular field of view, or given mirror diameter and f.l., find parabolization depth. Similar charts are for exit pupil, for diagonals and for compound reflectors. Not merely a lot of arithmetical slavery saved but the designer can swing a straightedge up and down the lines and visually arrive at his optimum condition, also getting more closely acquainted with the whole gamut. For these charts Gasper asks about a quarter of what might be charged; evidently it's a labor of love. He is a member of the Amateur Telescope Makers of Cincinnati.

SOLICITUDE—or something. Professional optical manufacturer who has evidently just heard of amateur telescope making hobby writes that he learns that amateurs in it "attempt to grind and polish their mirrors themselves," and kindly offers to "prepare to produce these mirrors in quantity." A medal will be awarded to the amateur who submits the most suitable reply (on asbestos) to this optical illusion. "Attempt." Green's

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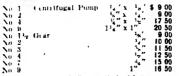
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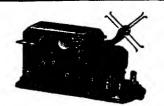


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OPERATORS HANDBOOK deals specifically with truck, bus, and farm and industrial tractor tires, presenting statistical material of interest to every operator of such vehicles. Particular attention is paid to truck-tire failures, including the heat-speed problem. Pocketsize, 68 pages. The B. F. Goodrich Company, Akron, Ohio.—Gratis.

Some Common Fallacies about Wood brings out many interesting facts regarding various types of woods found in the United States. For example: Wood does not necessarily decay with age. Decay is caused by the attack of a fungus. Request Mimeograph R1167. Forest Products Laboratory, Madison, Wisconsin.—Grans

THE EARLY HISTORY OF AIR TRANSPORTATION, by Edward Pearson Warner, is a 74 page booklet based upon a James Jackson Cabot Professorship lecture. It has been prepared in an attempt to reconstruct the atmosphere of significant periods in the development of aeronautics and to suggest historical implications and the influence on the future of the more significant events. A brief bibliographical appendix gives valuable references to source material. Norwich University, Northfield, Vermont.—50 cents.

What's What in Rayon is a 22-page booklet that tells in question and answer form everything that the average user of rayon could possibly want to know about the fabric. For example: What is spun rayon yarn?; How has rayon contributed interesting color effects in fabrica?; In what price ranges are rayon fabrics found?; Do they stretch?; Will they wash?; Will they shrink? Rayon Division, E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware.—Gratis.

THE PROBLEMS OF A CHANGING POPULATION is a 306-page book containing a report of the National Resources Committee concerning some of the major problems of our human resources. Data is presented in regard to population trends, anticipated stable population, changing age groups, migration within the country, health, education, economic opportunity, and so on. Government Printing Office, Washington, D. C.—75 cents (coin).

THE STORY OF WESTERN ELECTRIC is a 32-page thoroughly illustrated pamphlet that tells of the work which has made possible the highly efficient telephone system that exists today. This service of supply for the Bell System is a gigantic, highly organized institution that has contributed largely to efficient as well as low cost telephone service. Western Electric Company, 195 Broadway, New York City.—Gratis.

RADIO TROUBLE-SHOOTER'S HANDBOOK, by Alfred A. Ghirardi, has been prepared to cover every phase of radio repair service. It contains hundreds of pages of tabulated job data condensed and tabulated for easy reference. A large number of charts and tables will aid the service man in his work. Radio & Technical Publishing Company, Department 35, 45 Astor Place, New York City—\$3.00. Illustrated circular free.

MICROSCOPE EQUIPMENT FOR THE AMATEUR is a 24-page pocket-size booklet that deals with microscopy as a personal hobby. It shows some interesting photo-micrographs and describes and illustrates various types of microscopes and other equipment that will sid in the pursuit of the hobby. Bausch & Lomb Optical Company, Rochester, New York.—Gratis.

PHOTOGRAPHY BY POLARIZED LIGHT discusses various types of Pola-Screena, describes the effects produced by their use, and illustrates these effects by drawings and photographs. Discusses exposure time, filters, accessories and negative materials to be used when employing Pola-Screens. Eastman Kodak Company, Rochester, New York, or photographic stores.—50 cents.

Radio Foro Loc, edited by Samuel Kaufman, contains 32 pages of information for radio listeners. It gives tuning data on American and foreign stations and presents 151 photographs of prominent radio stars. Recent advances in television are also covered. At your radio dealers or from National Union Radio Corporation, 57 State Street, Newark, New Jersey.—15 cents

Improving the Farm Environment for Wild Life is a 62-page illustrated booklet which shows how the farmer can best provide for the small birds and animals that live on his farm, with a minimum of trouble and expense and a maximum of return on the investment. Farmers' Bulletin No. 1719. Superintendent of Documents, Washington, D. C.—5 cents (coin).

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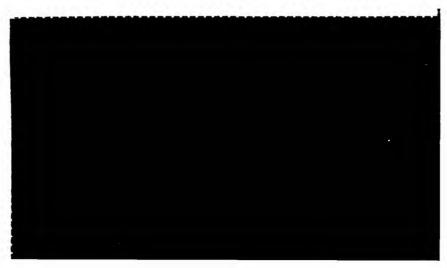
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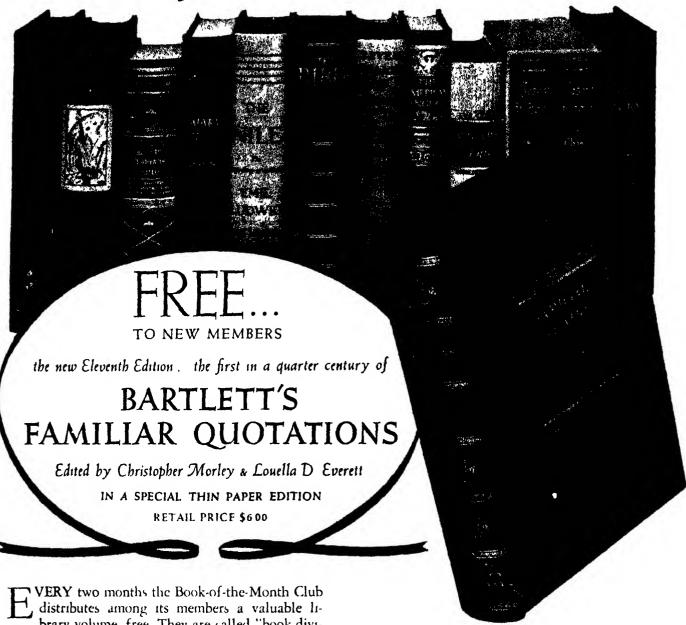
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SCIENTIFIC AMERICAN

Dwned and published by Munn & Company, Inc.; Orson D. Munn, President; John P. Davis Transpirer, J. Sheldon Tilney, Secretary, all at 24 West 40th Street, New York, N. Y.

NINETY-FIFTH YEAR

ORSON D. MUNN, Editor

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TWO of the apes, both females, of the colony of pedigreed "apes of science" described in the opening article of this month's number are shown on our front cover. One has a young haby at her breast and each is grooming the other. Momentarily, however, the chimpansee at the right is distracted by the photographer. These and other apes are being bred to be used by psychologists, biologists, and anthropologists because apes are man's nearest animal relatives.

OUR POINT

Astrology

STATEMENT on this page last A month explained why this journal does not conduct the scientific investigation of water witching or dowsing for underground water which is often urged by readers. Its editors are still more frequently urged to investigate and disprove astrology. This question has been

given some thought.

11

As is made clear by the science of logic, any argument between two persons or sides on a given question must be based in final analysis on a premise which both sides accept in common. If there is none, there is no real meeting between the minds of the contestants they never come to actual grips at all The logic that flows on and on may be wholly flawless, yet, being based on dif fering premises, it merely agitates the atoms of the atmosphere. Most of the superheated arguments which we human beings get into (and enjoy, anyway!) are instances of this unobserved error.

Reduced to nakedness it seems to us that the argument about astrology falls in the same category: the scientifically minded and the occult minded cannot agree on premises in common. True, when cornered, the astrologer asserts "You believe in the distant influence of gravitation between planets, don't you' Well, then ... " This, however, turns out

to be a sort of pseudo-premise

To us it seems unlikely that any kind of direct attack will knock out astrology, in the useful sense that it will succeed in knocking astrology out of the people who follow it. We scientific people might "disprove" it up to the hilt (if necessary) but still our disproof would not have the hoped-for effects. A surer though slower process seems more likely to be the constantly improving standards of general education.—A. G. 1.

Sociological

NOT quite five years ago, the legislative experiment known as Prohibition came to an end. Preceding its demise by almost a year, an editorial in the June, 1932, Scientific American urged that quick action be taken by the government in concurrence with the rapidly growing sentiment of the people in favor of repeal. Our reasons were three-fold. First, we were aghast at the federal deficit of \$903,000,000 that had piled up during the fiscal year 1931 and the prospect of another totalling two billions in 1932; and we predicted a government revenue, to use against these deficits, of a billion dollars a year from legalized

control of liquor. There was also to be saved a large part of the enormous prohibition-enforcement outlay. Second, repeal would promote temperance! Third, the underworld would have, in repeal, amputation of its very great source of income-an income with which it had financed an unprecedented wave of crime and had seduced "the law" itself

What, then, has happened in five years? Just this; all three of our predictions have been fulfilled. From liquor, the government realized revenues totalling a billion dollars in 1937. Temperance has made such headway that, in 1937, the American people drank just over a gallon of spirits per capita compared with two gallons in the normal. pre-war year 1916. Moreover, on this point, statements have recently been made to the effect that less liquor is heing consumed in public and more in the calm atmosphere of the home. As to bootlegging, little need be said. Gone is the rum row that used to lie off each of our coasts, speakeasies have been reduced almost to the vanishing point, and still seizures have come down from 25,000 in 1930 to 11,407 in 1937 Bootlegging has, in fact, been demoted from the ranks of big business, and the few remaining "big shots" of crime have been forced to fall back into less lucrative, more easily detected rackets.

Sociologically, this experience should have a meaning for all those who think they know what is best for the American people and presume to translate then personal opinions into laws It should show, for one thing, that our people are a pretty level-headed and dependable lot Given personal freedom of action in regard to liquor, they have more than come up to scratch and shown their self control and temperance Give them more chances to express their individuality. where this is now denied them by fiat, and they will without doubt show such evidence of temperate judgment and action as will redound to the benefit of all.—F. D. M.

Canals

FIFTY years ago the Panama Canal was still under construction and seemingly insurmountable obstacles loomed ahead. Regular readers of our feature "Fifty Years Ago In Scientific American" have caught.glimpses of the troubles that beset de Lesseps and of the sentiment which, at that time, was growing strongly in favor of a Nicaraguan canal. We cannot here go into the political and financial machinations that made possible the final completion of the Panama Canal, but recent developments have once more opened the whole subject of marine transportation between the Atlantic and Pacific, particularly for our naval vessels and auxiliaries.

Pleas have been made for bombproofing the Panama Canal; agitation has been renewed for a second canal across Nicaragua, partly to relieve pressure on the Panama Canal in time of stress and partly to provide a second avenue for merchant and naval vessels in case of damage to the existing waterway. Such damage, particularly in time of war, would be disastrous since it would force our warships, troop-ships, and those carrying needed supplies and food to travel the extra thousands of miles around the Horn. Bomb-proofing the Canal is a large order, but it is obvious that every precaution must be taken to prevent disaster at any one of the many strategic points along its course.

On the other hand, a second waterway would be of great value in times of peace as well as in the event of war. It would go far to insure that marine traffic would be uninterrupted by any cause and would make doubly difficult the destruction of our invaluable link between the two oceans. The way is open for the construction of a canal across Nicaragua. This country holds a 99-year lease on the right-of-way. Experience in the construction and operation of the Panama Canal has taught many valuable lessons that could be applied in the work on another canal. As shown by a note on the "Fifty Years Ago" page in this number, the surveys of the Nicaraguan canal route had even then been carried out with great care and foresight "in marked contrast with those previously made for the Panama Canal.

With such a background, and with the advantages of Lake Nicaragua as a part of the proposed canal, there should be no untoward difficulties in pressing the work to completion. The way is open. The end is a desirable one. Our merchant vessels and our battle fleets must be assured of a safe passageway between oceans. And the route through the proposed canal would be some thousand miles shorter than the present course through the Panama Canal. The advantages of two canals are obvious. May the powers-that-be see with a clear eye and do their utmost to bring to completion a project that will be of tremendous value to the United States as well as to the commerce of the entire world.-A. P. P.

50 Years Ago in . . .

SCIENTIONE AVIORRICAN

(Condensed From Issues of February, 1889)

CANAL—"Every discouraging report, for the past year or two, touching the probability of the completion of the Panama Canal, commenced by M de Lesseps, has caused public attention to be yet more earnestly attracted to the Nicaragiaa Ship Canal project. The great difficulty and the enormous cost of the work thus far done at Panama have compelled those interested in the Nicaragiaa route to be extremely thorough and careful in their surveys and estimates, which have been completed with a detail that is in marked contrast with those previously made for the Panama Canal."

MACHINE GUN—"The Maxim gun. has met with marked success, and has been adopted by nearly all the European powers, including England, France, Germany, Italy, Switzerland, Austria, and Russia. The gun is soon to be tested at the proving grounds at Annapolis, with a view to procuring its adoption by the United States government. The speed of fire of the rifle caliber gun using the American cartridge is very high, being 700 per minute. The one



pounder will discharge 400 shots per minute. A six pounder adapted to fire shrapnel and grape canister will discharge at the rate of 150 per minute... The Maxim automatic mitrailleuse is so constructed that, on firing a single shot to start the gun, the force of the recoil is utilized for extracting the empty cartridge case and for effecting the various operations necessary in reloading and again firing the arm."

EXHIBITION—"The first impression one receives on a general survey of the Paris exhibition buildings is an exceedingly favorable one. There is a something about them that is pleasantly impressive, and this feeling augments as one passes through the various departments . . . It is reported . . . that Edison proposes to span the machinery department with a rainbow of incandescent electric lights, which would, without doubt, he a most effective exhibit."

ALLIGATORS—"The alligator of the South, like the buffalo of the West, is likely soon to become extinct. The slaughter of the alligator for its hide, like the slaughter of buffaloes for their hides, has been so great that it may be only a few years before the lonely lagoon of Florida will have lost its last survivor."

SMALLPOX—"In Paris, where the law requiring vaccination is feebly enforced, the mortality from smallpox ranges from 1.36 to 10 0 to the 100,000 inhabitants, while in the principal German cities, where the vaccination laws are rigidly enforced, the death rate is but 1.44 to the 100,000 inhabitants, London, under compulsory vaccination, has a death rate from smallpox of but 0.6 to the 100,000 inhabitants."

PIPED WIRES - "The Consolidated Gas Light Co., of this city, some years ago, in laying a gas main, took advantage of the opportunity to introduce a telephone line in it, suspending it from insulators within the main. Excellent results were attained. On recently opening the main the wire was found to be coated with naphthalene, but the line as such was intact."

CIGARS—"There are 1,800 cigar factories in New York City. Of these the great majority employ from one to fifty hands each. Large factories, of which there are 350, employ from 50 to 500 hands, while the largest class of factories, of which there are only ten, employ from 500 to 1,000 hands."

VERSATILE—"A well recently bored for gas at Pitisburgh delivers fresh water, salt water, and gas at same time. There are two casings, one within the other, the outer one, 100 ft. down, taps a fresh water stratum, while the inner pipe reaches the salt water and gas at 200 feet down."

TALL.—"The Fiffel Tower in Paris had reached a height of 761 feet on January 9, 1889—the highest structure upon the globe."

WIRELESS—"When we contrast the present state of electric science... with its condition a year ago, we are struck with the remarkable advances that have been made.... The most important experiments bearing on the theory of electricity have been those of Hertz on the propagation of electrical disturbances... Hertz has obtained electric oscillations of a very short period—several hundred millions in a second—and he has shown that electro-magnet waves caused by them are propagated in the surrounding space, and are reflected and interfere with one another as do waves of light."

REFRIGERATION—"The refrigerator cars in which meat is brought from Western stock yards to Eastern markets are 29 feet long inside, 8 feet 2 inches wide inside, and 7 feet 2 inches from the floor to the cross beams to which the hooks are fastened, above which is a space of 14 inches to the roof. At each end are galvanized iron tanks filled with a mixture of pounded ice and coarse salt. . . . The cars are iced the day before shipping, refilled just before loading, and are iced again every twenty-four hours at regular stations on the route."

CLAY—"Electricity is being more and more used for the purification of kaolin and other porcelain clays. The clay is sifted on to a rapidly revolving horizontal plate, which is surrounded with powerful electro-magnets, which retain the particles of iron.... The process is said to be comparatively cheap and very rapid, and since its introduction many clays hitherto rejected as containing too much iron have become of value for the manufacture of pottery."

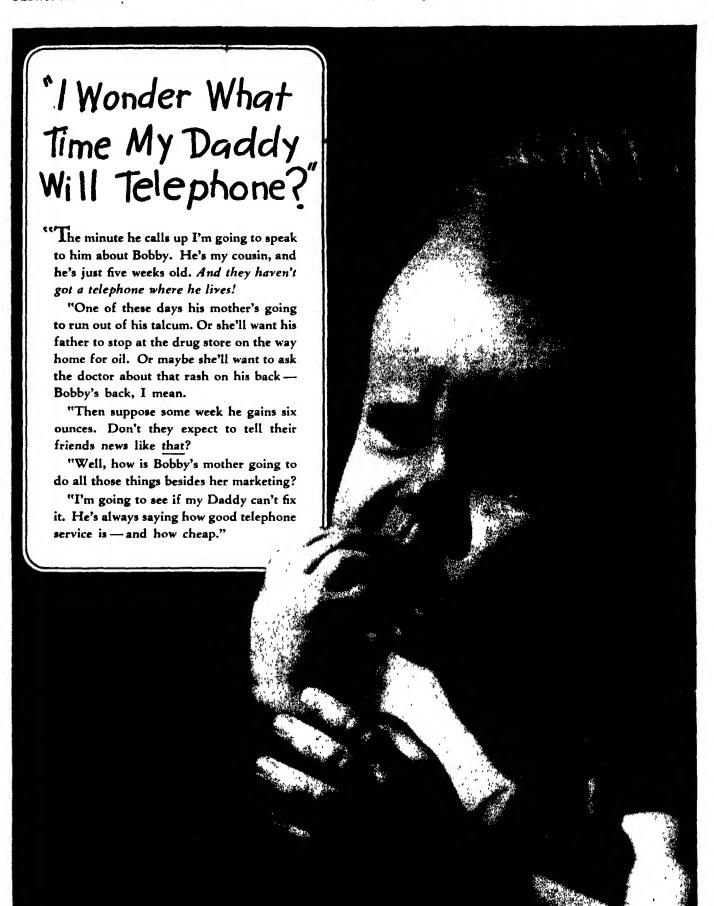
AND NOW FOR THE FUTURE

(How Climate and Weather Assume a Dictatorship Over Human Affairs, by Clarence A. Mills, M.D., Ph.D.

(A 13-Mile Tunnel that Was Bornd Under the Handicap of an Underground Rainstorm, by Andrew R. S Boone.

Cludustrial Wastes, their Effects on Edible Fish, and the Solution to the Problem, by L. M. Fisher.

CExcavations at Biskupin, an Early Iron Age Village in Western Poland, by J. Kostrewski.



BELL TELEPHONE SYSTEM

You are condicilly invited to visit the Bell System exhibit at the Golden Gate International Exposition, San Francisco



PATTERN OF A GOLFER-BY PHOTOGRAPHY

MORE and more industrial problems are being solved by the ultra-speed photography process developed by Dr. Harold Edgerton at Massachusetts Institute of Technology. To the manufacturer of golf balls and clubs, for example, the above photograph from the newly established Research Department of A. G. Spalding & Bros. has an important story to tell. In making it, the camera shutter was opened and, as the golfer started his swing, an intense light started flashing so that each flash caught the club in a different position. Here, each exposure was made at a speed of 1/100,000 of a second. The teed ball, of course, was registered on the film with every flash during the downward stroke. The golfer did hit it—and the hall flies off to the right. Note the upward flight of the tee, as well as the angle of the club face and the fact fliat the golfer lifted his head!



The Laboratory Building of Yale Laboratories of Primate Biology, Orange Park, Florida. Here in cleanly cages chimpanases are being bred for the uses of science, as experiments made on the apes may be of greater value to biologists, anthropologists, and psychologists than those in which dogs, rats, guineapigs, monkeys, and other animals more distantly related to human beings are employed

Dated Chimpanzees

PLORIDA boasts the world's strangest colony—dated chimpanzees. In the salubrious atmosphere of subtropical Orange Park, there jabber, leap, climb, shriek, mutter, and multiply dozens of pedigreed anthropoid apes.

And, incredibly enough, in this flourishing colony, these startlingly man-like creatures are to be bred—or rather, manufactured—to specification. A standardized, all-purpose ape is the ideal laid down in the blueprints. Nowhere else in creation is there such a laboratory.

If, some fine day, you should drive through the balmy and luxuriant northern Florida countryside, and at last reach the low and spreading buildings of this great laboratory—for great laboratory it is, and not a zoo—you would readily single out cage after cage of squat, dark, hairy figures—babies, youngsters, and adults—loafing in the shade or waddling clumsily about in the sunshine. Coming closer, you could not help noting how bright-eyed, healthy, and clean is this animal colony. And you would observe no scratching of fleas. Indeed, each cage is well-kept.

Perhaps with astonishment, as you watched the attendants going about with food, apparatus, and notebooks, you would absorb the significant fact that human beings rarely get more careful consideration or more individual attention, Indeed, the colony was founded because these apes are among the most manlike of all creatures—and because an eminent scientist had the fortunate idea that the more like human beings these animals are treated, the

more the discoveries directly

applicable to human problems.

Yale's Ape Colony, in Florida, is a Laboratory in Which Discoveries Directly Applicable to Man are Being Made on Man's Closest Relative, the Ape



The chimpanzee who showed where his gums ached. Moos in his fifth year

"A single chimpanzee wisely used may be worth more than thousands of guineapigs," says the moving force and guiding genius behind this unique undertaking, Robert M. Yerkes, a distinguished professor of biology at Yale University. "The primary intent of the administration is to produce chimpanzee subjects which by type, breeding, rearing, and general adaptation shall be pre-eminently suitable for research purposes in lieu of human subjects." The laboratories are under the auspices of Yale University and have been supported financially by the Rockefeller Foundation.

There are countless human problems of utmost importance which are vitally in need of solution but upon which research simply cannot be carried out with human subjects. Such experimentation must deal with dire diseases, including syphilis, and with the brain and problems of behavior, as well as with the more intimate aspects of glands, sex, and reproduction. The ape must come to the rescue of man.

How strikingly human the chimpanzee at heart—especially after his confidence in investigators and their good will has been brought to a high point over a period of years—has astounded even Dr. Yerkes. He relates an actual incident to drive the fact home.

Moos, a young male, had been ill, and was convalescing. But he was evidently still in pain and would refuse all solid food. Moos had already been given repeated close examinations. His attendant, however, determined to find the source

of his pain. Refusing solid food suggested a toothache. The investigator went into the cage to

By BARCLAY MOON NEWMAN

look Moos over once more. The young chimpanzee greeted him cordially, and calmly, even hopefully, submitted to the new examination. Yet the investigator could see no evidence of dental difficulty. Shrugging, he turned away to open the door and leave. Moos thereupon reached over and plucked the attendant's coat, drawing him back. Then he poked up his upper lip with a finger of one hand, and with a finger of the other hand pointed to a spot on his upper gum. Peering in-



The twins—only chimpanzee twins known—enjoying a playing spell

tently, the attendant was at last able to discern a swelling. A new tooth was about to break through And Moos thus solved his own difficulty.

Perhaps still more remarkable, the chimpanzees soon learn that no harm is meant them even during uncomfortable experimenting and, like Moos, will eagerly try to help the investigation along. When Fifi has several times been made to sit down at a table and has been afterward trussed up with complicated apparatus, from which stimuli may mysteriously come, one day she rises to the occasion in true ladylike fashion Upon being introduced into the experimental chamber, she walks to the table, seats herself in the little chair, placidly folds her arms and waits for the investigators to truss her up and perhaps shock her with electric currents

Also, with almost human intelligence, they learn to obey spoken commands, gestures, and gentle shoves. Often it is feasible merely to go through the motions of what is expected of the ape, and he or she will react by imitation of the investigators' actions. Of course, when Fifi, Moos, and Mimi do their chores admirably, they are rewarded suitably with a banana or an orange. Next time, their confidence increasing, they are successfully encouraged to do more difficult tasks,

In fact, affection, and ludicrously even deep sentiment, may spring up in the maturing chimpanzee's heart and the eager creature will attempt to outdo himself. Further, sentiment may go so far as to prove decidedly embarrassing—hugging and kissing and little love-taps are demonstrations of the surging emotion within. On the scientists' part, the chimpanzee youngsters are treated like so many children.

Under this regime of extraordinary care and sympathy, and of research into the manifold difficulties and unknowns incident to undertaking the production of apes, the colony has indeed flourished. At the start, in 1925, there were only two chimpanzees, of opposite sex. To day, the population is approaching three score.

So, for more than a decade, increasing numbers of chimpanzees have been maintained alive and healthy in captivity. Their handling and rearing have been so successful that they have multiplied rapidly. This demonstrates how scientifically and painstakingly the enterprise has been developed

THE chimpanzees are subjected to a rigid routine—so that they have enough exercise, a diet making for health, and sufficient repose. Their diet has been given intensive study—perhaps more study—than any other factor. Not only are the calories measured, but each essential—nutrient—carbohydrate,—fat, protein,—mineral, and vitamin—is—provided. Few groups of human beings are better nourished.

Strict hygienic measures are unbreakable law Well-groomed are these apes, and quite free from vermin Mental hygiene, too, is not neglected. No chimpanzee is ever teased or otherwise unnecessarily annoyed Over-excitement of these charges is avoided. And throughout its entire life, every creature is kindly treated

At present, and for a long time to come, practically all these thoughtful procedures on the part of the apes' supervisors are directed toward the eventual mass production of a standardized chimpanzie. The ideal called for in the blue-prints has its features as carefully detailed as those in any set of plans for a new model car. The records of every series of experiments carried out with the aid of any given ape are analyzed laboriously in the light of this ideal.

"The ideal chimpanzee must be small and robust," states Dr. Yerkes, who then adds a multitude of other characteristics to be established by careful breeding and selection. The ape must be disease resistant—"preferably with varied specific immunities" to diseases. Reproduction must be rapid. And he must not take too long to grow up and reach maturity.

Intelligence is important Furthermore, Mr. and Miss Chimpanzee must

understand how to behave himself or herself though shifted from one environment to another. He and she must be active, yet not destructive; co-operative, emotionally stable, dependable, and kindly disposed towards the world in general. On the whole, the ideal ape is easy to handle, being ever calm but capable of warm friendship.

Finally, the ideal race not only is to breed true to type (or standard) generation after generation, but also is to be a producer of twins.

Why twins? In twins are hidden untold treasures for the searchers after the secrets of heredity and of the environment's influence in modifying heredity. In human twins, the vast and almost immeasurable hereditary differences between human beings are reduced to a minimum. The study of a pair of twins, particularly if reared in different environments, tells scientists a great deal about what traits and talents are fixed by heredity and what influence a poor or a good home or education or group of contacts may have upon inborn character. Such studies have already transformed the science of criminology as well as many another important social investigation. So, chimpanzees being remarkably similar to men, chimpanzee twins can be expected to carry on the profitable work

Thus far, only one pair of twins has blessed the colony. But this pair marks



Chimpanzee family, mother holding the baby as in playful display

an important beginning. The capacity for producing twins may run in families. Hence these twins, properly mated later with other twins, may give rise to apes given to twinning.

Along other lines, significant discoveries applicable to man have already been made by using chimpanzees. The staff of investigators has contributed many new facts concerning the processes of learning, the development of intelligence with increasing age, and the power to adapt oneself to changing environments. In most respects human behavior

is not by any means fundamentally different from behavior in higher animals. Moreover, observing animals always gives excellent leads towards the secrets of basic human emotions, attitudes towards new companions and new situations, and personality as a whole.

Observing a steady stream of near-tohuman-type births in monkeys and apes is today providing the medical specialists with knowledge concerning birth problems. That such discoveries are heing made and are of vital meaning to man is not surprising. Never before have medical experts been able to approach so close to certain features of childbearing or been able to experiment so searchingly in this field.

A great list of experiments has already been drawn up in this early stage of the program. The invaluable investigations should proceed, ever more fruitfully, as the colony continues to increase After a decade, the success of the colony and of the plans for it have been proved. A major scientific and medical feat is being achieved.

Like all pioneers, Dr. Yerkes has been first a dreamer, and then has found in his dreams inspiration for action.

TWO decades ago, while musing upon the search after the secrets of life, and especially human life, he spotted a failure on the part of his fellow scientists. Everywhere biologists, psychologists, and medical investigators were studying the structure, vital chemistry, and diseases of animals—guinea-pigs, rats, monkeys, sometimes (rarely) chimpanzees. With what wonderful precision these investigators were working! How accurate all the vast and delicate modern laboratory equipment! How marvelously keen and sensitive these innumerable gleaming 'scopes!

But just here a starting thought flashed into his mind. Precision instruments were, throughout the scientific world, being used on hiological specimens—primarily so that the resultant discoveries could be applied to man. Yet upon what sort of specimens were all these painstaking observations being made? Here was the surprising neglect.

The alley cat, the stray dog, a monkey kidnapped in the jungle, pondered Dr. Yerkes, are the utterly unknown specimens upon which precision measurements are being wasted. Who knows the history of such specimens picked up haphazard-often diseased, of unknown age as a rule, probably often abnormal in ways disastrous to true scientific precision? And as for any of the forms most closely related to man, they are obtainable only with the greatest difficultyand when obtainable are decidedly the most haphazard of all specimens. All available apes were simply snatched from the jungle or bought from natives.

Strikingly poor specimens make all



Mona, the mother, and her hoy and girl twins, photographed when one year old

findings strikingly poor—the highest scientific care comes to nought where thousand-dollar instruments are turned upon ten-cent specimens. And often it is a far cry from the guinea-pig or the albino rat, or even the monkey, to the high estate of man.

"Truly," asserts Dr. Yerkes, "extraordinary risks have been taken." After new drugs are found beneficial in animal maladies, they are tried out on human beings. But who knows to what sort of animal this new drug is really valuable? It may be to an abnormal animal—the exception—or only to some lower creature at most distantly related to man.

Now Dr Yerkes was, and is, more than a mere biologist. His speciality is that remarkable field, psychobiology, whose grand attempt it is to explore the influence of bodily processes upon mental characteristics and behavior and, at last, problems of society. And in this work, which is so closely bound up with human interests and the entire science of man, he had come to study the ape as a form more like man than any other living thing. The chimpanzee had been his choice—really had to be the anthropoid for his experiments. Gorillas are almost unobtainable. Orang-outans are sluggish and solitary. Besides, the chimpanzee is the ape most tractable, most adaptable to conditions of captivity, the least expensive (though still costly), and is by far the best understood scientificallyas to anatomy, living processes, nutritional needs, reproductive peculiarities, and general personality.

And so, not denying the possible future use and possible peculiar advantages of the gorilla and orang-outan—advantages still to be discovered—Dr. Yerkes looked to the chimpanzee. And

the chimpanzee, we see, has not failed him.

Years were spent in planning the program, including methods of keeping the animals alive and healthy, and means of bringing about successful multiplication. The blueprints of the ideal were finally worked out. To these specifications the chimpanzees were eventually to be molded through wise breeding procedures. Northern Florida offered the most favorble climate,

IN 1925, a young mate and a young fe-male were bought from a dealer, who had brought them in from Africa. Of course, these creatures-the Adam and Eve of the Florida Eden-being taken in the jungle, had no pedigrees. Still, a start had to be made somewhere. At any rate, Adam and Eve turned out to be fairly satisfactory and quite healthy. Later, several additional apes were purchased. But meanwhile, natural reproduction under the favorable colony conditions commenced. Infants began to appear, not merely healthy but happy and friendly as they developed into chimpanzee children, from buth accustomed to friendly man. Now there have been more than a score of perfect births-including the birth of the twins who may give rise to a dynasty of twinning apes.

The standard, all-purpose chimpanzee, peculiarly fitted for scientific experimentation and perhaps for later (though still uncertain) routine tests in hospitals—to save the lives of countless men—is on the way.

"The aim," Dr. Yerkes tells us, "is to create a breeding colony which shall have only dated individuals of known history and condition."

A FASTER ARMY RIFLE

OR many years the Ordnance Department of the United States Army has devoted an intensive effort toward the development of a satisfactory semi-automatic, or self-loading, rifle Such a rifle would omit the side bolt of the present Springfield and permit the individual soldier to fire an entire clip of cartridges without once removing the butt from his shoulder. A distinct advantage foreseen would reside in the soldier's ability to hold his rifle on his target without the necessity, as with the Springfield, of dropping the gun to the port position to slide the bolt by hand. It would be necessary for him only to

pull the trigger for each shot Some years after the World War, the search for such a weapon narrowed down to a caliber .276 rifle. Before a final decision was reached on this weapon, a caliber .30 semi-automatic rifle was completed after many years of work by John C. Garand, a designer in the employ of the Ordnance Department at the

Springfield Armory. The results of tests on this weapon were so excellent that the caliber 276 was abandoned and the Garand semi-automatic rifle adopted as the standard weapon for the United

> The new Garand rifle, at left, is without the side bolt. However, it does have a small operating lever for the mitial"cocking," as shown in photograph, at right, of open breech and clip of eight cartridges

Garand Semi-Automatic Rifle Adopted by U. S. Army . . . Self-Loading . . . Fires Clip of Eight Cartridges . . . More Rapid Fire, Gun Held on Target

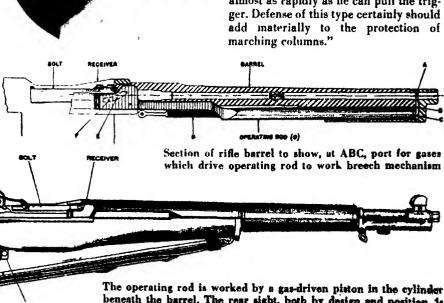
States Army. During the next few years, our entire Army will be equipped with this weapon.

The new M1 rifle is described in Army Ordnance by Frank J. Jervey as "a gasoperated, clip-fed, self-loading, shoulder weapon slightly over nine pounds in weight. It fires the same ammunition as the caliber .30, M1903 (Springfield) rifle and all standard U.S. caliber .30 machine guns. The ammunition is supplied in eight-round, reversible, en bloc clips which are fed by hand into the magazine of the rifle. Upon being inserted, the clip depresses the follower which in turn releases a catch, allowing the bolt to go forward under the action of a compressed spring, stripping the top cartridge from the clip and chambering it When the last round in the clip is

fired and the empty case is ejected, the clip also is ejected and the bolt is retained in the open position ready for the insertion of the next loaded clip.

"It generally is conceded that for short periods of fire the M1 has the value of approximately three bolt-action rifles. . . . The lack of fatigue after continuous firing and the ease with which the rifle can be held on the target throughout the firing of a complete clip is remarkable for the type of fire. . . . The average rifleman is capable of firing about 40 shots per minute." One case tells of 80 shots at 200 yards in one minute, all hits within the target's "4" ring.

"The rifle shows its greatest superior ity over the Springfield in anti-aircraft work. . . . In the M1 (the Garand), the 'kick' is very light, and it is easy to keep the rifle on the target throughout succeeding shots. The advantage of this for defense against high-speed, low-altitude aircraft where the target is present for a fractional period of time can be readily appreciated. Try, for a moment, to visualize a company of soldiers on the march, equipped with semi-automatic rifles, An airplane traveling at a speed of about 200 miles an hour suddenly appears over the top of the trees. Within a split second, each man can bring his rifle to his shoulder and begin firing eight rounds almost as rapidly as he can pull the trigger. Defense of this type certainly should



beneath the barrel. The rear sight, both by design and position, is said to be the finest, most efficient, on any military rifle in the world

Bubbles

A Fascinating Little Experiment Reveals a Surprise and Later May Lead to Some Utilitarian Purpose

WHAT shape is a common bubble of air rising through water? Some night answer offhand: "Round." Others with better memory of casual observations might put it: "Spherical, in general, but constantly wobbling." The ultra-slow motion picture series at the right shows what really happenshapes and antics previously unrealized.

In the top picture a balloon-shaped bubble of air surrounded by water is just leaving an adjustable orifice at the bottom of a vessel 3 inches in depth.

About 1/100 second later it is breaking off and starting to rise—second picture.

In the third picture, approximately 1/1000 second later, the bubble is on its way upward. The clongation at its bottom has contracted and been pulled upward into the bubble. Note the truncation of the bottom thus produced, also the tip of the pulled-in part dimly showing within the bubble.

In the fourth picture, taken about 1/300 second later, the bottom is pulled farther in and the little tip inside has cast off a tiny water droplet.

In the fifth this little drop is rapidly moving toward the top of the bubble.

In the sixth it is about to strike the top.

About 1/600 second later, in the seventh, it has struck the bubble's ceiling, made a neat little "gooseegg" on its head and rebounded downward.

And now see what happens! That little blow from the droplet has set up waves that travel all over the bubble and give it, 1/100 second after the previous picture, the strange shape shown in the eighth picture.

The final picture, taken about 1/400 (.00024) second later, shows the amazing shape a bubble can assume!

To researches such as this there are several well-known types of reaction. The person of limited imagination, who calls himself "practical," scornfully says: "So what?"—and walks away, pitying the poor experimenter. On the other hand, the scientist, all boy, probably remarks that these observations provide a fascinating illustration of Somebody's-law, and that the industrial people probably could find some application of them to industry—leave it to them. The broad-gage industrial man is boy plus scientist plus truly practical, so he says: "Let's play with these bubbles some more, and see if we can find something applicable in them—you never can tell."

The application hasn't yet been hit on, but "the practical applications of the bubbling of gases through liquids are almost universal, and we have no doubt that there will be such," stated Dr. Gustavus J. Esselen, of Boston, Massachusetts, in describing this research before the American Chemical Society. "The processes of flotation of ores, the formation of lather and suds with detergents, the washing of gases both for absorption and for cleaning, the formation of gaseous equalsions, the evaporation of liquids into

gases as in carburetion, and numerous other applications of contact between gases and liquids can easily be cataloged," according to Dr. Esselen. "Which of these will be affected and to what extent can at the present moment be only guessed.

"What has been learned so far is that the bubbling of air through water is far more complex than one would anticipate. Instead of rising through the liquid in the spherical or nearly spherical form resulting from the action of surface tension forces, air bubbles assume a variety of forms apparently through the operation of forces hitherto unsuspected.

"A separate set of forces is set in operation by the formation within the air bubble of a tiny globule of liquid water which, given momentum by the force of surface tension which breaks it away from the inner surface of the bubble, bounces up and down within it. These globules of water do not merge with the bubble walls, but possessing high speed, and hence substantial momentum, they bounce off the inner surfaces of the bubbles as if the surface film lining the bubbles were made of rubber and the globules were tiny balls.

"The effects of these collisions between bubble wall and water globule are evident in wave motions imparted to the bubble, which continuously changes its shape as it rises through the liquid. These can be readily seen in motion pictures and in prints of parts taken from them.

"STRIKING, too, is the difference in behavior evident when a wetting agent is added to the water in which the bubbles are formed. The basic effect of the wetting agent is to reduce the surface tension of the water and thus the strength of the film surrounding the bubble. For this reason, the bubbles show a pronounced tendency to merge together and the bouncing of the globule of water can no longer occur because at the first contact with the weakened surface film it is able to penetrate into the surrounding liquid.

"Quite obviously, the behavior of bubbles in liquids depends upon the character of the liquid and more particularly on the strength of the surface film which it forms around the gas bubble.

"Throughout our experiments the temperature of the water was maintained at 20 degrees, Centigrade (68 degrees, Fahrenheit). The size of the orifice varied from 0.53 millimeters to 7.5 millimeters, covermg a ratio of area of 1:200. Four different air velocities were used-50 cubic centimeters, 150 cubic centimeters, 600 cubic centimeters, and 1200 cubic centimeters per minute. With an air flow of 150 centimeters per minute the tendency for these globules to form decreases as the orifice size increases from 0.53 millimeters to three millimeters diameter. With the three millimeters orifice, no globules are observed with an air flow of 150 cubic centimeters per minute. As the orifice diameter is further increased the globules are again formed. These results are presented in the following table:

Globule Formation Inside Air Bubbles

e per minuta 150	Diameter of Orlfice millimeters 0.53	Glubula Parmatian percent 50
150	2	20
150	3	0
150 .	49	80
150	7.5	100

"The figures presented in the column headed 'Globule Formation' were obtained by counting the number of air bubbles in which the formation of globules was observed and calculating from the total number."









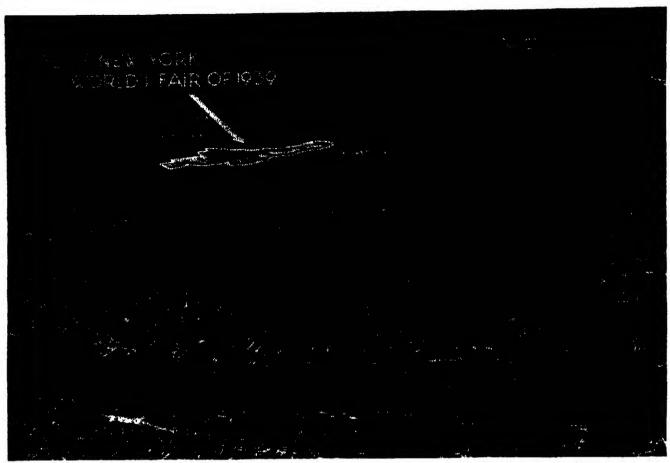












The Fair is directly northeast from the midtown business section of Manhattan in the foreground

Up From the Ashes

TEOGRAPHICALLY, New York r has the tremendous advantage of possessing one of the world's finest harbors and a very lengthy landlocked shore-front for waterfront and shipping developments. There are, however, some physical disadvantages in this since, of the five boroughs of the city, four are on islands separated by arms of the sea. The development of the city has, therefore, been largely a question of bridges and tunnels, either for rapid transit or vehicular traffic. Curious backwaters have developed in various portions of the metropolitan area due to absence of these facilities or failure to exploit them

Near the geographical center of the city, which is also very close to the center of population, there developed in the Borough of Queens one of these backwaters, bounded roughly by Queens Boulevard—which is opposite 59th Street, Manhattan—Flushing River, Flushing Bay, and the East River, and covering an area of about 16 square miles Because of marshes and deep indentations, the area could not support, financially, the necessary reclamation or improvements, grading, and proper paving.

New York World's Fair 1939 a Glittering Cinderella . . . Engineering Difficulties of Filling in and Building Upon Ash-Filled Swamp Muck

By JOHN P. HOGAN

Chief Engineer and Director of Construction

Many years ago the then city of Brooklyn, needing a place to dispose of its ashes, selected the largest one of these marshes for the purpose at a point where it was about one and one-half miles wide. For a number of years, not only the ashes, but also all the non-perishable debris of an average population of from one to two million people were deposited here. As the ashes were deposited, they sank into the mud to a maximum depth of 40 feet and piled up to a height of nearly 90 feet. Infested with rats, they added to the unattractiveness of the already dreary landscape.

Straddling one of the main entrances to New York, this ugly area formed a blot of the first magnitude. The dumping of ashes was stopped several years ago after about 50,000,000 yards had been placed, but the task of reclamation was thought to be too expensive and too stupendous to be immediately undertaken.

About 1932 things began to happen. The old Triborough Bridge Project was revived. This bridge now connects the three Boroughs of Queens, Bronx, and Manhattan, entering the latter at 125th Street, crossing the East River at Hellgate, and entering Queens at the village of Astoria.

About two years before the opening of the Triborough Bridge, a group of enterprising businessmen of New York decided to hold a World's Fair in New York in 1939 to commemorate the 150th anniversary of the inauguration of George Washington in New York City. In searching for a site that was both

readily accessible to the heart of the city and large enough for the purpose, they found that the desolate marsh fulfilled these requirements better than any other available site. The city plan had always included the rehabilitation of the marsh and dumps to form a grand city park 50 percent larger than Central Park.

Under the stimulus of providing a site for the World's Fair, the city agreed to advance all the necessary items in the general plan for immediate construction and to add thereto the cost of dredging two lakes and leveling the ash dumps over the remaining marsh in order to provide a foundation for the park. The city agreed also to build a permanent park headquarters for use as an exhibit building for the City of New York duiing the Fair and to use its best efforts to get the state to build as its exhibit a permanent amphitheater seating 12,000 people which could also be utilized duiing the Fair

THE Fair Corporation agreed to build four permanent bridges. It agreed further to landscape the site in such a way that the planting done would be useful for later park development, to build several permanent park roads and to leave for the initial stages of the park development all the temporary roads all bridges across Flushing River, and any other structures built by the Fan Corporation which the city would require. A lease, embodying these terms, was signed on June 29, 1936

No time was lost. Prior to the determination of the details of the formal agreement, the contract was awarded for leveling the site on June 15, 1936 Although this required dredging of nearly a million yards of material, and transportation of nearly seven million vards of ashes, the work was completed in eight months, or in April, 1937, two years before the date of the opening of the Fair. The vast tributary works, the road and bridge building, sewer con

struction, and so forth, were put into work as rapidly as detailed plans could be prepared.

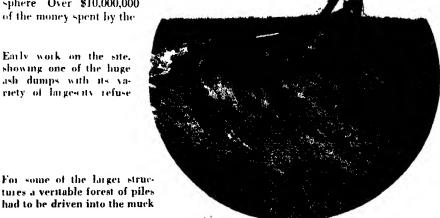
The work done by the Fair Corporation itself is only a fraction of the building program for the exposition. The Fair itself has constructed 20 exhibit buildings, a theater, three large railway stations, and a group of administration and operating buildings. In conjunction with the states, it has constructed 13 buildings to house the exhibits of 37 states; in conjunction with the Federal Government, it has constructed eight buildings to house the official exhibits of foreign nations. The building program of participants is much more impressive. Twenty-three of the 62 foreign nations and 43 industrial corporations will erect their own exhibit buildings, and over 50 buildings and amusement devices will be erected in the Amusement Area. It is expected that the total expenditures on account of the Fair will be in the neighborhood of \$150,000,000.

In addition to the exhibit buildings, the Fair Corporation has constructed and will operate utilities, roads, general landscaping-including the planting of 10,000 large trees from 12 to 20 inches in diameter--five permanent bridges and 11 temporary bridges, several large parking fields, and the Theme Center, including the well known Trylon and Perisphere Over \$10,000,000 of the money spent by the

Early work on the site. showing one of the huge ash dumps with its variety of large-city refuse

Fair Corporation is underground. Some of the items which helped to make this total are 51 miles of roads and paths; 34 miles of storm drains, sewers, and water mains: 90 miles of electric conduits; and over 500 miles of piling including piles driven by private exhibitors. In this work, and in the development of the foundations, the majority of the engineering problems have been encountered and solved.

The original filling and first stabilization was a delicate operation. The ash dump covered roughly 300 acres of the 1200 acre site. Elsewhere, the site was composed of a peat covering about three feet thick overlying from eight to ten feet of very fine silt with a very high water content Rock was about 400 feet deep below the surface, and therefore out of economic range for foundations Underneath the liquid mud, however, was a bed of very fine sand covering the entire area and formed like a trough with the axis of principal depth three and one-half miles long approximately in the middle of the site. This sand has a supporting capacity of about two tons to the foot, which indicated that it





would support piles loaded with about 18 tons. On most portions of the site where large amounts of ashes had been dumped, the natural surface would support a concentration of about 1500 pounds to the square foot. It was therefore evident that the direct weight of the buildings could be supported on the

The main danger, however, was that of lateral movement either during the filling operation or during the construction of the foundations. The original disposal of the ashes had forced them down into the mud, in many cases to a depth of 40 feet. This had been partly compensated for by driving water out of the underlying mud, and partly by the rise of a series of mud waves around

the edge of the dump. In these mud waves, the original peat covering had been forced up in many cases as much as 20 feet above the surface of the swamp and in some cases the underlying mud had flowed through the peat covering. Elsewhere, the peat cover formed a mat upon which to place the ashes excavated from the dump, but it was necessary to place the ashes in three-foot layers and to allow no slopes of more than three feet in 100 to develop, otherwise further flow and additional mud waves might have been created. The bed of the old channel which meandered through the site had to be filled, and this furnished one of the principal problems since it was 15 to 16 feet deep and had no peat cover.

The problem of equilibrium was successfully met. Within certain areas, subsequent settlement continued locally for over one and a half years after the completion of the first filling in April, 1937. The only way in which this local settlement could be met was by a continuance of filling operations. Finally, in the summer of 1938, the last of these local settlements ceased, and today the site is perfectly stable. The process of consolidation was greatly accelerated by the early construction of a large number of storm drains.

In the lower ground along the banks of the new river and the new lakes, it was in many cases necessary to put the sewerage drains and conduits on piles,

and where soft spots developed in the new foundations for roads in this area they were corduroyed with three-inch wooden planks recovered from pile butts. Of the total length of 37 miles of road it was necessary to treat only a mile and a half in this manner. One of the aids in stabilization, where the ash cover was thin, was the action of the piles themselves. The underlying silt is so liquid that it is not compressible. Therefore each pile represented the displacement of an equivalent amount of water from the mud. To meet any lateral movement, most of the pile foundations were connected with reinforced concrete struts.

FLEXIBLE type of pavement was A chosen, both because it would be easier to repair after local settlements, or after excessive wear, and because it was the cheapest type which would give good service. The bus routes and main highways consist of a four-inch thickness of cru-hed stone on which was laid a three-inch layer of cold laid plant-mix bituminous macadam. This is in two courses consisting of a two-inch binder and a one-inch wearing surface. For lighter traffic, a similar plant-mix bituminous macadam is laid directly on the ash fill after proper consolidation. This pavement consists of 2½ inches of binder and a one-inch wearing surface. In courts and gardens, the walks consist of a thinner bituminous mixture laid on a base of cinders.

The most serious foundation problems were encountered at the site of the Trvlon and Perisphere, particularly as the Trylon has a maximum wind load equal to about four times its weight. The foundation problem was solved by driving about 1100 creosoted piles from 90 to 95 feet into the underlying sand. These piles were then covered with heavy reinforced concrete and, in the case of the Trylon, these had to be heavy enough to resist the over-turning effect of the wind load. As the Perisphere rests on eight columns, a pile and reinforced concrete foundation was adopted, the whole load of approximately 2500 tons being transmitted through a circular ring girder into the pile foundations.

The Fair itself now promises to be not only the largest of the world's expositions, but one of the most beautiful. Important, too, are the destruction of an eyesore and the promise of a future park, which have started the construction of thousands of apartment houses and dwellings in the neighborhood and thousands more are projected. It has been estimated that a million people will move into the neighborhood within the next ten years.

When Grover A. Whalen, President of the New York World's Fair 1939 Incorporated, opens the Fair to the nations of the world on April 30, 1939, he will have followed to completion a modern miracle—the rise of the New York World's Fair from the ashes!



Even in its far-from-complete condition in October, 1938, the Fair presented a spectacular contrast to the original site

Test Your Soil

Home Gardener or Commercial Grower May Test Soil With Simple Kits, Grow Better Plants

GARDEN plot or grain field is a tiny chemical laboratory, is made up of countless soil particles, contains complex and intricate chemical processes, and is never the same from week to week, changing as the crop draws on the plant food resources, modified by weather and seasons. The fertility of the garden or farm is directly dependent on what goes on in that earth zone where feeder roots draw sustenance from the earth.

In the past, soil testing to guide the grower has been largely confined to extensive laboratory processes and out of reach of the average grower. Now, however, there is available a simple field kit with which anyone can make tests of soil and determine from them the fertility of any given plot of ground.

As little as two dollars will secure a field kit of the simplest type. Anyone who can read newspaper English and distinguish colors may, in a matter of minutes, run the four principal tests on a soil sample.

The first and most important determination is whether a soil is neutral, acid or alkaline. Some crops, such as asparagus, alfalfa and heliotrope require a soil definitely alkaline. To put such plants in acid soil is inviting failure. Other plants, such as rhododendrons, cranberries, parsnips, and gardenias will be retarded or destroyed by alkalinity. Every soil test kit contains a pamphlet listing the alkali-acid preferences of plants and the degree of either condition they demand. There are instructions as to how to change a soil from acid to alkali, or the reverse.

The other three primary tests are for

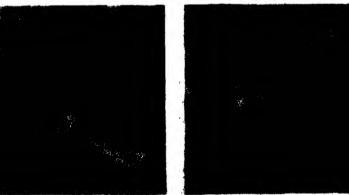
nitrogen, phosphorus, and potassium. These are the soil chemicals which are required in large quantity by growing plants. The objective of a soil test is to make certain they are present in sufficient quantity and in the balance required by the crop being produced.

Nitrogen is the element chiefly required in leaf and stem growth. Such crops as cabbage and lettuce and bluegrass lawns draw heavily on the nitrogen in the soil. Phosphorus content of soil is linked with the production of flowers and fruits. Any crop of orchard, flower garden, or grain fields needs adequate phosphorus to "make the crop." Potassium stimulates root growth; such a crop as the lowly potato demands this element in the correct balance in the

Each year gardeners and farmers spend millions for "complete" fertilizers that contain a set ratio of the three principal plant foods-nitrogen, phosphorus, and potassium. This gunshot application



Larger soil testing kits can be used by non-technical market growers



All testing operations are as simple as pouring a test solution into a tube



The solutions are filtered in the larger sets, in order to clarify colors



stographs equetesy Sudbury Soil Testing Laboratory The small soil testing kit, with complete instru tions for using, is about the size of a small bot

of plant foods may not have enough of one or too much of another chemical to supply the needs of the particular crop. The soil test shows what is present and what is lacking, and the grower may buy only those chemicals needed to make his soil highly productive. The possible economy is obvious, for the grower may now be paying out money needlessly for chemicals that are already present in his soil.

THE technique is simple. With an ordi-I nary spoon, dig two inches under the soil surface and scoop up a soil sample. It should be dry enough not to wad up under pressure. Each tube in the kit has a colored cork; each color is for an individual test and each test is made every time in the tube assigned to it. The test tube is filled one fourth full of soil. The kit contains small bottles of test solutions. Selecting the one designated for the test being made, fill the test tube until it is half full. Cork it, shake it, and set it aside until earth particles settle. The liquid above the soil will take on a color. This color is the key to the test.

There are four color charts in each test kit, one for each test. Match the color of the liquid in the tube with a color shade on the chart for the test being made. The shade or tint on the chart will be designated by a key letter or number. Turning to the pamphlet, one finds the answers all worked out. From the resulting data, one can make up his own fertilizer, "tailor-made," for his particular soil. -Arthur Hawthorne Carhart.



Colors in the solutions are matched against those in key color charts

Powder Metallurgy

A NEW process for the manufacture of metal objects is now available to industry. It permits the alloying of metals without the customary melting and casting, while entirely new compositions can be produced from such unrelated materials as metals and abrasives.

This process is called powder metallurgy, and although it has been known and used for more than a quarter century, it is only now coming into its own as a tool of production. In a manner which seems as simple as filling a doctor's prescription (but isn't) it provides your automobile with oil-less bearings, clutch facings, and spark plug inserts. It offers your home and your family radio tube parts, lamp filaments, dental alloys, warming-pad mixtures, and permanent waves, while to science and industry it contributes X-ray targets, welding electrodes, grinding wheels, and other essential products.

The art, which is characterized by the compression of metals in the non-fluid state, seems now to be on the eve of further commercial expansion. Developments begin to issue in a steady flow; promotion and research run neck and neck to get results now and to promise more in the future, yet there remains a vast unexplored domain which makes definitive evaluations premature.

The exact date of powder metallurgy inception cannot be set. If we say that it began as a science around the turn of the century, the statement can be defended. At that time came the production of tungsten filaments from the metal powder, involving all the applications of technique—preparation of the powder, compression, heat treating, and subsequent processing to form—whereas the production of bronze powders which

Tungsten Filaments Started It . . . Now Superior "Alloys" Made Without Melting . . . Components Retain Identity . . . Can Alloy Metals, Non-Metals

By PHILIP H. SMITH

Some of the Products Made Possible or Improved By Powder Metallurgy

Bushings
Bearings
Brushes
Cemented Carbides
Clutch Facings
Brake Bands
Contact Points
Medals and
Coins
Welding Rods

Grinding Wheels
Resistance Elements
Thermostats
Magnets
Lamp Filaments
X-Ray Targets
Brazing Compounds
Metal Wire and
Sheets

antedated filaments by a half-century required only the first of the several producing steps

The manufacture of tungsten filaments called for the metal in a pure state, in bar form, ready for drawing into fine wire, and since tungsten has a melting point of 6100 degrees. Fahrenheit, there was the problem of getting high enough temperatures to reduce the metal to a fluid state as well as the problem of obtaining refractories that would stand such heat. If, however, tungsten oxides are reduced by hydrogen to leave tungsten in a pure powdered state, then the powder can be compressed into bars, sintered or heat-treated, hot-swaged, and drawn.

The process sounds extremely simple, but at the outset it was highly complex.

It was necessary to find a way of eliminating impulities and discover means to control not only the structure of the metal particles but their size and assortment of sizes as well. Then there had to be research to find binders which would be eliminated upon hear treatment; and long study went into determination of the proper pressures to obtain desired densities.

Upon the knowledge acquired by metallurgists in their quest for the best means for producing tungsten filaments, and subsequently molybdenum wire (another high melting point metal), has been reared the new science of powder metallurgy. Today there is hardly a metal known and used by man which is not available in powder form, and used either as a single element or in combination with others.

Developing satisfactory methods for powdering and refining metals to approach some measure of standardization has been a long process and an essential step in the new metallurgy. Out of these labors have come eleven basic processes. These have beer listed in the following manner: machining; milling (by ball mills, stamps, attrition mills, and so on); shotting (pouring molten metal in water, air), granulation (by stirring molten metal while solidifying); atomizing (disintegrating by steam, compressed an); condensation of metal vapor; reduction of oxide powders; chemical precipitation; electrolytic deposition; sintering (for the production of alloy powders in friable form); formation of an alloy followed by dissolving or otherwise remov



Tungsten oxide, placed in long retorts in trays (at left), is heated in an atmosphere of hydrogen until reduced to metallic powder. The powdered metal is then placed in a steel form and pressed into a bar under 14 tons pressure per square inch (right)



ing one of the alloying constituents. The relative importance of these processes cannot be set unless you measure arbitrarily. Importance in volume is one thing; the value of the item produced is another. It is enough to say that the process used in any particular instance is determined by the metal and the use to which its powder is to be put.

The range in processes is very wide, as can be seen by examining a few at random. The grinding process, for example, produces powders by crushing in stamp, ball, or attrition mills, and is quite simple. Brittle and tough metals can be handled in this manner, but mallcable metals must be stamped. Powders so produced are flaky in form, a good example is metal paint pigment. Atomizing, on the other hand, requires forcing a thin stream of molten metal through an orifice and then hitting it with a stream of steam or compressed an. This method permits a very close control of powder size and regulation of the size at will. It is employed when powders are to be used in molded products, although copper cannot be so treated Still another process which permits close control is that of reduction from the compounds, in particular the oxides, chlorides, and hydrides, using temperatures below that which will melt the metal. Tungsten filament, as previously mentioned, is produced in this manner

ONTEMPORARY with research to develop suitable powders has gone much study in the art of compressing And here, in this second phase of powder metallurgy, are revealed many of the most striking achievements and more than a hint as to limitations. The production of metal parts or products from powders requires pressures ranging from 15 to 50 tons per square inch. Now these pressures can be obtained, as the presence of parts proves, but the surface area of pieces is very definitely limited at the moment by the mechanical difficulties of building presses which will compress large surface areas economically. Further difficulty is encountered when trying to produce parts having great thickness to be compressed. It requires a pressure ratio of three to one to do a job with proper porosity or density because the average density of the powders is about 30 percent that of the cast metal. The mechanical difficulties are complex enough, but if you try to compress metals of different densities the problem is intensified by physical considcrations. w

There are authorities who express confidence that these problems will be solved to broaden the field of metal powder application. One specialist has said: "We can't press around a corner yet"; but he declares that striking gains in this direction are soon to be announced. Certainly the fatricacies of form achieved

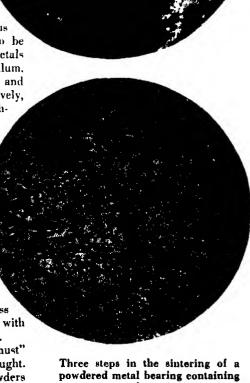
with die casting cannot be duplicated with metal powders, yet there has been steady progress and the products of today reveal an advance in complexity of form over those produced only a short time ago.

While experimenters have been trying to discover how to press large objects out of powders, they have been busy also perfecting the process of making small parts. Powders are now being produced commercially on a tonnage basis so that more and more things can be made economically. Likewise, there have been improvements made in dies and presses so that parts can be made more quickly and with more uniformity. The speeding-up process has brought about press work at the high rate of 40 to 120 pieces per minute, using single dies. Now, with multiple dies, output can be increased substantially.

Probing the science of powder metallurgy brings two questions uppermost. Probably the reader has formulated them already. Why employ metal powders anyway? In what particular is the process superior to the older method of combining metals in their fluid state? And the second query is: What makes the particles stick together?

Our résumé of the early experiments with tungsten revealed one reason for employing powders. It is when metals are too refractory to be melted or cast conveniently. The metals of tungsten, molybdenum, and tantalum, with melting points of 6100, 4700, and 5100 degrees, Fahrenheit, respectively, cannot be handled by any other method without incurring grave troubles with equipment and losses by volatilization and oxidation But this is not the only instance where powder metallurgy makes a unique contribution. If you would make a product out of several components and wish to retain the essential identities of those components, powder metallurgy does the trick. The cemented carbides illustrate this excellently. Whether made with tungsten, tantalum, or titanium, the hardness of the carbides is retained along with the toughness of the cobalt binder.

Metal powders also play a "must" rôle when certain structures are sought. Oil-less bearings, made from powders of copper, tin, and carbon, are given a porous structure by control of pressure, while increased porosity can be obtained by an admix of volatile salts which evaporate upon heat-treating to leave pores for oil absorption. Again, this new metallurgy serves uniquely when it is de-



Three steps in the sintering of a powdered metal hearing containing copper, tin, and graphite. Top: After compression, before sintering. Light areas are tin and dark are copper. Middle: Partially sintered. Gray areas are bronse formed by interdiffusion of the two metals. Bottom: Copper and tin powders completely "alloyed" by diffusion



The three powdered constituents of an automobile bearing metal are mixed and placed in this briquetting press. The resultant solid is the actual formed bearing

sired to combine components which cannot be alloyed because of extreme differences in melting points or because of immiscibility. By surmounting this difficulty, the powder process has furnished superior electrical contact points, bearing and magnet composites, and certain welding electrodes.

THERE are many instances where powder is used by choice rather than necessity in the manufacture of metal products. Permanent magnet alloys, for example, can often be made at less expense and more easily by this process. Then there are products in which usefulness is enhanced by the higher purity possible with powder. Injury which may result from the use of de-oxidizers and de-gasifiers in the melting and casting process, can be avoided with powders.

Still another advantage is the permissibility of taking two or more metals and compressing them in layers of separate elements. By this means, composition effects can be localized. Valve parts provide a practical example.

Powder metallurgy, by its very achievements, has proved where its advantages he and has marked out the territory for exploitation. But it is still young too young to have promulgated a water-tight explanation of the mechanism of the bond. There are many theories and each may contain some truth. It is claimed that the clean surfaces of the powder permit a cohesion or adhosion of the particles under the combined action of heat and pressure. It is also thought that there is an interlocking of the metal particles because in many instances the structure of the particle is dentritic, or toothed. The action of pressure is not to be overlooked as significant in the creation of the bond.

Under pressure the air between particles is expelled and replaced with particles deformed by that pressure, giving an angularity which perhaps facilitates the union.

It has been suggested recently that the friction during compression may generate a welding heat momentarily where the surfaces are in contact. This theory arises as a result of studies on the action of metallic surfaces in contact and rubbing as occurs in bearings. Here, it developed, the friction produced sufficient heat to create slight molecular diffusion on the surface.

So the answer to the question: what makes the bond?—the greatest problem among many—must be left to the future. There are vast differences between the science of casting fluid metals and this newer one of compressing metals in the non-fluid state. Such factors as re-crystallization and grain growth, for example, are unlike and call for long study before it can be said that powder metallurgy has built a solid backlog of -cientific understanding.

Meanwhile events move rapidly. The mystery of the bond isn't holding up commercialization. Only a year ago it was thought impossible to make tool steel or high carbon steel by the powder method. Now the problem is thought to have been solved. Stainless steel, another impossibility, is declared to be a reality, while behind locked doors are other achievements yet to be released. But each and every item which becomes a reality must prove its worth competitively, so judgment as to value must be withheld. What we see happening is mainly significant to us as straws in the wind.

AT the moment, the leading application of powder metallurgy is in production of ductile metal from tungsten, molybdenum, and tantalum, and in making cemented carbide tools, porous structures, electrical contact and electrode materials. But if it is true that a way has been found to get sufficient pressures with economy for large area work, and if the complex dies now in process of development and experimentation prove satisfactory, the way will be open for the manufacture of many more metal parts and products.

Prosperity for this new process seems to be "just pressing around the corner."

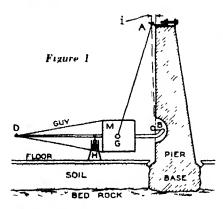
Information and photographs courtesy of: General Electric Company, General Motors Corporation, Handy and Harman, Charles Hardy, Westinghouse Electric and Manufacturing Company



Pressed bearings, made as in picture above, are sintered to cause diffusion of constituents. Here, they pass through a high-temperature furnace on a souveyor

THE AMATEUR'S SEISMOGRAPH

A SEISMOGRAPH is neither difficult to build nor tedious to operate. Of the many forms, the Bosch-Omori horizontal-pendulum type is probably the easiest to make and maintain. To house it a small separate building is preferable, but if this is too expensive a corner of the basement will be suitable. The corner will have to be walled off to stop convection currents of air, also to preclude accidents to the apparatus As a foundation, a pier (Figure 1) should be set at least two feet in the earth beneath the floor, or on bed rock. It should have no direct contact with the floor. The zone



of earth will to some extent insulate the pier from disturbances originating with in the building. Concrete walls of base ments have also been used to support seismographs, with some success (Figure 2).

For the "heavy mass," on the pendulum, which remains virtually stationary while the earth and apparatus move, a compactly shaped cylindrical piece of metal G, weighing more than 50 pounds, will be required and a visit to a junk dealer is quite likely to reveal it already in usable form. However, as a larger mass will prove to be more effective in overcoming friction, the nearer the mass approaches 500 pounds in weight the better. A very effective seismograph can be made with a mass of 200 pounds. The mass need not necessarily be in one piece, as several disks may be bolted together, or a canister filled with shot will answer the purpose.

The mass, represented at M in Figures 1 and 2, may have its axis in the boom, as shown, or at right angles to it. The lines formed by the boom BD and the piano wire suspension AG should pass through the center of gravity of the mass. In the case of a 200 pound mass the distance BG should not be much more than one toot, while the distance to the end of the boom may be three to five feet. This will

an all the second

Instructions for Building and Operating in the Owner's Cellar an Instrument which Will Record Quakes from the Most Distant Parts of the Earth

By AUSTIN E. JONES

Improving Circumstances Favor the Amateur

RETURNING from his work, a man is met at the door by that familiar refrain, "Dinner is on the table, so don't delay a single minute" He promises to "be there just as soon as I can wash my hands," and starts toward the bathroom. Then he hesitates, glances furtively backward, ducks suddenly into the cellar doorway and is gone. Time marches on. Some 211/4 minutes later he emerges breathlessly from his little seismological laboratory with a yard of grimy smoked paper, to which he points and announces with gusto to a rather disgusted waiting wife that "there has been a tremendous earthquake today and a long way off" As he eats his chilled meal he talks on and on about hig earthquakes and particularly about this one (his wife seems to be listening but is thinking about hats). When he pronounces that the quake was in the Far East those present exchange winks, but tomorrow's papers will say, "Heavy Quake Does Extensive Damage in Java '

The man is an amateur seismologist.1

For years past there has been evidence that numbers of amateurs would like to build their own earthquake recording instruments, but until quite recently there has been a lack of literature on the subject, in a form suited to the needs of the beginner. Most professional writings on seismology have been abstruse and mathematical. This situation is changing Commander N. H. Heck, chief seismologist of the United States Coast and Geodetic Survey, has published an all-around, semi-popular treutise, "Earthquakes." Prof. L. D. Leet, in charge of the Harvard Seismograph Station, has written a detailed semi-scientific treatise on practical seismology, a book which makes available to the amateur who will do a little studying an elementary technical understanding of seismograph and earthquake principles. And now a seismologist who has built seismographs for professional use tells in the accompanying article how to make an instrument that will function for the great world-shaking, distant quakes that are chronicled in the newspapers every few days. At last, therefore, improved circumstances have made it better possible for the amateur to proceed.

The author of the accompanying instructions (see "American Men of Science," the "Who's Who" of American science) did graduate work at the University of California, then was an assistant-scientist with the United States Geological Survey at Mt. Lassen. Later he placed two seismographs in Alaska, and has spent four years as assistant to the widely-known volcanologist, Dr. T. A. Jaggar, Director of the Hawaiian Volcano Observatory of the Department of the Interior, where the study of earthquakes of the peculiar volcanic type is made a specialty. "A fair amount of my time," he states, "has been concerned in devising seismographs from material at hand, as well as constructing cellars for them." So far as is known, no definite instructions for making a seismograph of the quality he describes have ever been published. The professional has always purchased his instruments ready-made, or has himself employed instrument makers to make them, or else made his own, and in each case no definite building instructions were written out because this was unnecessary,

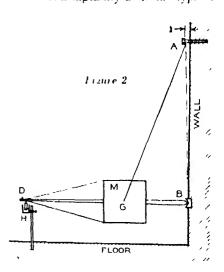
Recently a Committee on Amateur Seismology was formed in the Seismological Society of America, the national organization for professionals and interested amateurs. This society publishes, at Berkeley, California, a monthly journal named the Bulletin of the Seismological Society of America, which is not entirely technical and abstruse, many of the articles heing readily understandable by the lay reader. Other journals publish occasional articles on seismology.

Readers who construct the apparatus described here are requested to communicate their results to the editors, who are interested.—A. G. I.

The first syllable—seis—of this troublesome word rhymes with ice, dice, lice, be increased by a lever or pen-arm (Figure 5). When properly suspended, this mass will swing about the hinge points A and B by flexure of the piano wire.

The axis of the hinge AB is inclined to the vertical by a small angle i, which in a good set-up can be changed by a screw thread at the top of the pier. In place of the pivot-and socket joint shown in Figure 2, at B, a suspension by means of a bolt across the face of the pier, and a short wire attached to the end of the boom, as in Figure 1, will make possible another casy adjustment, but no change in period can be made without changing the angle i For teleseismic, or distant, work the period should be somewhat longer than seven seconds (approximately) per swing and return, but in the neighborhood of 12 seconds the pendulum is likely to become unstable. The purpose of an adjustment at B is to correct the slope of the boom, for example, in cases of tilt due to temperature, earth changes, or foundation settling

COMPLETE record of a quake, A such as the professional usually prefers for exhaustive interpretation, requires three instruments at right angles, each recording its component of waves which arrive from all directions, but any component will suffice for general interest, and in one component stations the boom is usually placed in a north-south direction. If the experimenter is not exacting at the beginning with regard to the direction which the instrument records, non adjustable ties may be made at 4 and G, and a pivot-and-socket joint made at B. It is the intention to suggest that the individual may to a great extent use his own ingenuity as to the type of



mass, boom, and adjustments. Generally the part *DM* of the boom should be light and rigid, the part *MB* being heavier and more rigid. The friction at *A* and *B* should be negligible. The smaller the mass the greater *MB* should be. However, a small mass—10 or 15 pounds, for example—would not work well unless *MB* were three or four feet long. Then

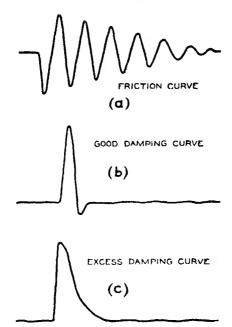
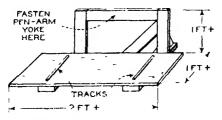


Figure 3: Some adjustment curves

DM must be short and the static magnification would be much less than with the heavier mass.

Once the pendulum is started vibrating in an arc of about one half foot, it should continue to vibrate for many minutes. If it will do that, it may be considered ready for the next step. However, while such an undamped pendulum will indicate earth movement, it will continue to move after the earth has stopped, and thus will give an erroneous indication. To stop this free movement, damping is required. Such damping, as described here, will



Tigure 4 For recording apparatus

induce the pendulum to follow earth motions fairly closely. A small amount of damping, H, at the end of the boom, as in Figure 2, will equal a larger amount near the mass, as in Figure 1. The choice is the builder's. In Figure 2 the damping would be about two square inches of vane sliding in heavy oil, or in Figure 1 many square inches. It also depends upon the size of the mass. The oil container should be adjustable in height, so that the damping will also be variable. Figure 3 shows how friction and damping affect the seismogram. When the pen is displaced it will write a decay curve, as in a. This form is due almost entirely to friction, and if the damping is increased the decay curve will be shortened. The correct damping is attained when the curve becomes similar to b. where the first displacement is about five times the second, with no third, and the

damping should be adjusted to this type of curve. Too much damping will induce a decay curve that does not recross the zone of rest but merely comes slowly back, as in c. However, the final adjustment is not made until the recording apparatus is completed.

To support the recording apparatus a wooden frame (Figure 4) may be used (though the frames of the Hawaiian Type seismograph are built of iron about 14 inch by two inches). The tracks should be built of metal rod or smoothed hard wood, so that the clock and drumcarrying frame will slide easily under the pen. The purpose of this track arrangement is to facilitate precisely positioning the drum under the delicate penarm without injury to it. The dimensions

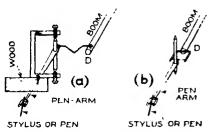


Figure 5. Two magnifying systems

shown are only approximate and may be varied. This frame will also accommodate a second pen-arm from a pendulum set up at right angles to the first, if this is later wanted as the amateur gains knowledge of seismology

The magnifying system is to be attached to the end of the boom, at D. Figure 1 or 2. The writer prefers the method of attachment shown in Figure 5, at a, consisting of cup and needle joints. The connecting link is depressed in the middle. as shown, so that it will remain balanced on the points, and is made of light, thin metal. Buttons may be soldered at the ends, in which the cups are punched. The needle on the pen-arm is placed about 1/4 inch from the pen-arm axis. As an alternative, the yoke and cross fiber method of Figue 5, b, may be used. Here again, ingenuity may assert itself. In either case the pen-arm axis is pivoted in a yoke fastened to the top of the frame (Figure 4). The magnification of the pen-arm multiplied by the magnification of the boom, BD/BM, gives the final static magnification of the seismograph. This is not the dynamic magnification. For illustration, an earth wave of 20second type records with a different magnification on a 10-second instrument than does a 3-second earth wave.

The pen-arm should be extremely light, yet fairly rigid. It is usually made of thin sheet aluminum rolled into a tapering tube (Figure 6, a) or a T-section may be bent, as in b. Approximate dimensions are ½ inch wide at the pivot or vertical axis, to ½ inch wide at the tip where the stylus is attached. The pen yoke at the tip should be very light—½

inch in greatest dimension—and may be attached to the pen-arm with wax.

The needle or stylus is a piece of fine piano wire—about No. 24 to 30—attached to an arbor from a watch, which is free to turn in dents made in the penarm yoke; or the watch bearings may also be used.

The next requirement is the works of a spring drive clock (Figure 7, a), or a

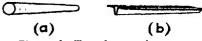


Figure 6: Two forms of pen-arm

Telechron motor, to drive a large drum d at the rate of one turn per hour. The connecting link b is constructed so that the drum axis cg will travel endwise on screw threads as it is rotated. This should record the pen motions for a day (or more if preferred), the record line spiral ling around the drum once each hour

THE drum should be large and light, THE drum should be many and nearly about 6 to 12 inches long and nearly a foot in diameter. The ends may be made of metal disks-cake tins might sufficeand the covering may be of cardboard, light wooden strips, or metal riveted on The drive end of the shaft is either square or slotted, in order that it may be turned by the clock, while the opposite end is threaded for a foot or more. If the threads extend through the drum this will facilitate fastening its ends by means of nuts and washers. For local work up to about 600 miles-the threads may be as close as 16 to the inch, but two to the inch is better for teleseisms. The drum should be three or four inches longer than the spiral, in order to allow free swing of the pen during large disturbances. In all, the axis will be about three times the length of the drum. The frame on which the clock and posts are mounted is to slide on the tracks of Figure 4

For recording, a piece of paper, smoked for each day's run, is placed on the drum. Its width should equal the length

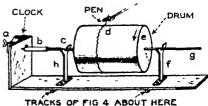
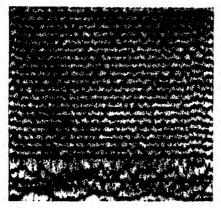


Figure 7: Drive, axis, and drum

of the drum, and it should be about two inches longer than the circumference, so that it may be folded and fastened by a small amount of library paste, as in Figure 8. While any paper will suffice, window-envelope paper has been found best. It is transparent, has a good gliding surface for the stylus, and takes paste just well enough to be easily removed from the drum without destroying its value as a record by mutilating it.



A small local portion of a seismogram showing two things; in its upper part the microseisms that shake the carth lightly but continuously and are due to pounding of the suif on the coasts of the continents, according to the most generally accepted theory, and in its lower part a portion of the record of an earthquake that originated in the Netherlands East Indies, traversed the earth, made the upper curves, was reflected to the other side of the earth and again traveled to this side to make a second tecord of itself (at the very bottom of the illustration). From Scientific American, Dec. 1938

For convenience in placing and removing the records it is well to have a separate supporting frame similar to the one in Figure 7, or else a wall bracket as in Figure 9, a. This frame can also be used for smoking the records. This is done by placing a kerosene lamp under the drum, which is rotated until an even coating of lampblack covers the paper. It is better, however, to build a smoking box (Figure 9, b), as a better coating is secured by its use. After the day's run the paper should be carefully removed (leaving on it not more than one or two finger prints!) and laid flat to be pinned on a hanger like the one in Figure 9, d The date and other data are written on it and it is then dipped in the thin shellacmixture in the vat (Figure 9, c). This thin shellac mixture should be about one fourth shellac and the rest alcohol Placing the storage tank lower than the vat or dipping tank will allow the vat to empty through the connecting hose and this will prevent some loss by evapora-

A defect of the seismograph just described is that no method is shown for

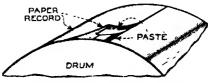


Figure 8: Simple fold for paper

recording time on the paper. This may want until the amateur is satisfied that the seismograph is working well, for it

may require several days before any world-shaking earthquakes occur to be recorded. A good visual test of the sensitivity of the instrument is the waviness of the recording line. These waves are microseisms and their amplitude will increase in stormy weather (typical microseisms are shown in the illustration in the central column of the present page). Traffic may also disturb the record. Microseisms should have periods of from three to five seconds or more, while traffic disturbances are in the neighborhood of one second in period. Sometimes

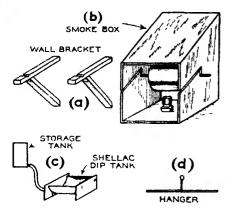


Figure 9 Accessory apparatus

traffic effect is magnified by trembling of the pen-arm, which may have nearly the same period. In such cases a small paper vane on the pen-arm often helps damp out this vibration

The time control is maintained by a separate clock, since the added load on the drive clock would render its rate too uncertain. The second hand of the clock should be so arranged that an arm fitted on its shaft will close a contact once a minute for a period of about one second (Figure 10). The current from a dry cell will suffice to raise the pen from the paper by means of a small electromagnet

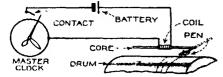
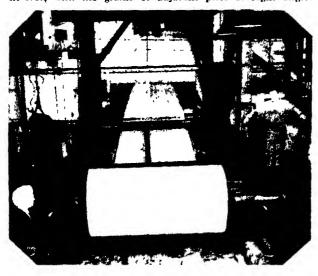


Figure 10 Electric time control

of 100 to 200 turns of magnet wire on a pencil of soft wires. This magnet is suspended above the pen by a rigid arm. The resulting gaps in the line will mark every minute of the day. To make them casier to read, hour marks can be added by contacts taken from the minute hand of the master clock. When the record is removed these latter gaps should be numbered on it with the proper hour. From time to time these marks from the master clock can be compared with radio time signals, thus obtaining for the record the absolute time correction for the beginning of each interval. This in turn will make possible the determination of the times of arrival of earthquake waves.

Removing the bark from a Douglas fir log, one of the first steps in the production of a form of plywood that finds wide use as wallboard, for structural purposes, in concrete forms, for subflooring and sheathing. Modern plywood, versatile and economical, is the result of co-operative research by forest product engineers and industrial chemists to produce a strong, light-weight material

2 Below: The log is set up in a lathe and the veneer, 1 28 to \(^{1}\)'a of an inch thick, is cut in a continuous sheet that is delivered to a multi-tier conveyor. Plywood is made up of an odd number of plies bound together with various adhesives, with the grains of adjacent plies at right angles



4. Below: Veneer going into mechanical roller driers, 150 feet long. Complete drying requires 15 minutes. Plywood structure is based on the fact that wood is strong with and weak across the grain. By binding together layers of wood with grains properly placed, a composite board is obtained that is uniformly strong



From Logs To Plywood



Arrow points to aperture between lathe knife and pressure bur through which the cut Douglas fir veneer runs at high speed. In other methods of producing special plywood veneers, the thin sheets may be sliced with a long, heavy knife, or sawn from the log

Below: Veneer emerging from the driers and being placed on sorting tables. The binding force of the transverse plies in plywood practically nullifies the tendency of wood to expand or contract across the grain, thereby reducing the co-efficient of expansion of a plywood panel to little more than ½0 of 1 percent



The state of the s

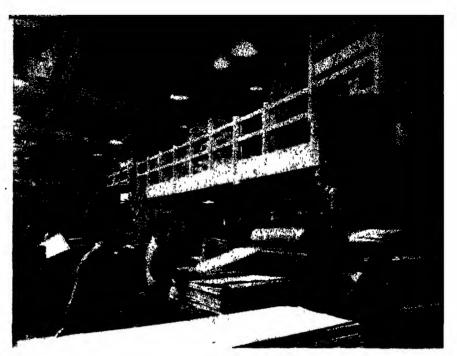
"Unwinding" Trees ... Stronger Lumber ... Made Possible by Research ... Co-operative Efforts

By A. P. PECK

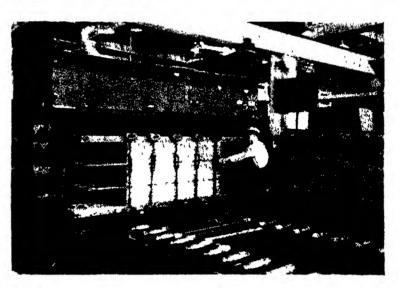


6 Close-up of the glue-spreading operation. Adhesives used are casein, phenolic resins, or soya-bean meal, according to requirements. The soya-bean meal falls into that rare category of products which are at once cheap and good. In plywoods other than Douglas fir, both vegetable and animal base glues are used

Right: Glued-up plywood is subjected to a pressure of 200 pounds to the square inch, in a hydraulic press. The I beams, rods, and turnbuckles are used to retain the pressure, thus releasing the press for use on the next batch. Note the roller-type conveyor



A general view of glue spreading showing the glue container at right center, with spreading rolls below. One of the advantages of plywood is its resistance to splitting. Nails may be driven close to the edge of the board without danger of splitting; also, nails hold well, cannot readily be drawn from plywood



9 Left: Sanding the surface of a finished, trimmed sheet of plywood. The panel passes through eight endless belt sanders, each of which carries a different grade of abrasive paper, the last of which gives a fine, smooth surface



10 Right: Finished Douglas fir plywood ready for shipment from the Bentile plant of the Aircraft Division of the United States Plywood Corporation. Trees, "unwound" and glued, are here ready for use in a multitude of applications in a wide variety of fields

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Sodium Skies

O clear night is really dark. Only when clouds shut out the sky altogether is there much difficulty in finding one's way in open country, and even when the clouds are heaviest it is possible to see the outline of a building or a tree against them. Impenetiable darkness outdoors is very rare, though it has happened, even at noon, during great volcanic eruptions

At first thought one would suppose that this faint illumination came from starlight. But photometric measures show that there is too much of it to be thus explained. More light comes from the vast numbers of stars invisible to the unaided eye than from those which we can see separately; but the sum of the two accounts only for about a third of the light of the night sky. A somewhat smaller part comes from the extension, all over the heavens, of the zodiacal light, that is, from sunlight reflected by an exceedingly thin haze of fine dust which extends well beyond the Earth's

orbit. But a very considerable part of the whole light originates in the Earth's atmosphere—as is shown by the fact that its strength increases toward the horizon, and so represents something carried round by the Earth's rotation

This "night sky" light shows a remarkable spectrum, consisting of emission lines and bands. It has long been known that the

green line, so conspicuous in the spectrum of the aurora, can always be seen with suitable apparatus in any part of the sky. By using spectrographs of great light-power, many fainter emissions were discovered in the blue and violet, and, in 1929, Slipher found that there were relatively powerful radiations in the yellow and red, which would be conspicuous at a glance if our eyes were as sensitive to these longer waves as they are to the green.

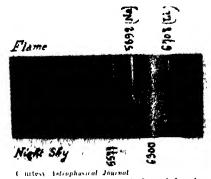
lust as the Sun's first rays at dawn strike the upper air, the conssions become stronger and new ones appear, evidently stimulated by the sunlight.

The origin of this extensive and complex spectrum has not been easy to determine fully. The light, even at best, is faint, and can be photographed only with instruments of small dispersion, so that it is not possible to separate double lines, except very wide pairs, nor to discriminate, in many cases, between individual lines such as are produced by atoms, and complex bands (emitted by

Recent Research Indicates that a Large Part of the Illumination We Commonly Designate as Starlight Originates in the Earth's Upper Atmosphere

By HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington



Tigure 1. Spectrum of the night sky

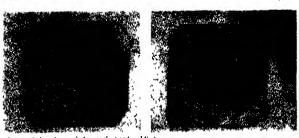


Figure 2. Fringes, 0.15 and 0.30 mm, etalons

molecules), though, with ordinary higher dispersion the distinction is obvious.

Moreover, the conditions of excitation, at the very low density of the outer atmosphere, are so unfamiliar that some of the strongest lines are of the "forbidden" type which it is haid to produce at all in the laboratory. The great green line, and a pair of sharp lines in the red are such forbidden lines, emitted by neutral atoms of oxygen. Many of the bands in the blue and violet arise from neutral molecules of nitrogen Some of the strongest features in the dawn-flash come from ionized nitrogen moleculeswhich are doubtless put into condition for their emission by extreme ultraviolet light from the Sun.

Identification of many of the infra-red bands still awaits more complete laboratory studies of gaseous spectra in this region. But there is a pretty strong line in the vellow which has till recently been a great puzzle. Laboratory spectra in this region are well known; but, for a reliable comparison we must have an

accurate wavelength of the line On low-dispersion plates it is very hard to secure this. The measures of several good observers, between 1929 and 1935, gave values ranging from 5885 to 5892 Ang strom units.

This immediately suggests the well known yellow sodium lines at 5889 98 and 5895 94. The spectrographs which were employed had not dispersion enough to separate the pair, and the recorded wavelength should be an average. This agrees well with the measures

of Slipher, the discoverer, in 1929, but the later values are discordant. A strong helium line is nearby, at 5875 62, but the measures do not admit of identification with this.

To settle the question, more precise measurements were required, and these have been made by a group of French observers—MM. Cabannes, Dufay, and Gauzit, of Paris and Lyon—

whose recent paper clears up the question most satisfactorily

A new spectrograph, with a camera of the remarkably high focal ratio 0.7 (that is, with focal length only 70 percent of the diameter of the lens!) made it possible to photograph the yellow line with a half hour's exposure. The dispersion in the yellow is 500 A per millimeter. The line on the plates is 1/50 mm. wide, corresponding to 10 Angstroms (enough to include both sodium lines, while the helium line, if present, would have been clearly separated). Ten good plates gave an average wavelength of 5894 ± 1 A—almost in the middle between the sodium lines.

FIGURE 1 shows one of these plates, with the green and red oxygen lines, and the yellow line. At the top the spectrum of a Bunsen flame is superposed on that of the sky. The sodium line produced by the flame agrees with the atmospheric line very closely indeed. The line at 6708 is produced by lithium in

the flame and does not appear in the sky

The critical question, however, is whether the night sky line is double. On the plates it is distinctly wider than the oxygen lines at 5577 and 6300, which are known to be sharp. Moreover, Dufay, in 1932, observed with a wide slit having a fine wire stretched lengthwise along the middle. With monochromatic radiation such as the oxygen lines, this gives a wide image on the plate with the narrow shadow of the wire down the middle; with the yellow line this shadow was less sharp.

This made it probable that the atmospheric yellow line was double, but fell short of proof. By making a spectrograph like the other, but two or three times larger in all dimensions, it should be possible to obtain spectra of greater linear dispersion, and find the line double on the photographs. But such an instrument would have been very expensive; and the analysis can be made with less costly apparatus.

The Fabry-Perot interferometer (itself a French invention) consists of two plates of glass with surfaces worked as accurately plane and parallel as possible, and set up with their inner surfaces parallel, and at a fixed distance apart. These surfaces are thinly silvered, so that they reflect back a part of the light and transmit the rest.

IF monochromatic light falls squarely upon such an apparatus, part of the light will be transmitted by both plates Another part will be reflected from the second back to the first, again by this, and then pass through. The light path will be longer by just twice the distance between the plates. If this double distance is an exact number of wavelengths of light, the two wave-trains will remforce one another -- as will also all the beams resulting from repeated reflections-and a great deal of the light will get through But, if the double distance is half a wavelength greater, the waves of the second train will interfere with those of the first-and very little energy will pass through

Now suppose that such an interferometer is set up in front of a camera, and pointed at a large luminous area which gives off light of a sharply definite wavelength. The same principle will apply; but the double distance for oblique rays must clearly be measured between the plates at the proper slant, and so will be greater, the greater the inclination. Hence, for light coming at different angles from the central axis of the plates, the device will alternately be nearly transparent and almost opaque, and our photograph will show bright and dark rings such as are exhibited in Figure 2, left, which is a negative on which the bright rings show dark.

Near the axis it takes a greater change in obliquity of the rays to increase the path by a given amount than farther away; hence the outer rings are more closely spaced.

If two radiations of slightly different wavelengths are present, there will be two sets of rings, of different sizes. If the double distance of the plates is such that one set of light-waves gets ahead of the other by a whole wave, in traversing it, the two systems of rings will be

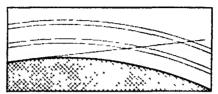


Figure 3. Upper cut is less oblique

superposed, but if the gain of one set of waves on the other is half a wave (or $1\frac{1}{2}$, $2\frac{1}{2}$, etc.), the second system of rings will be half-way between those of the first.

For sodium light the second situation occurs if the plates are 0.15 mm apart, and the first if their distance is 0.30 mm.

Figures 2, left and right, show the results obtained with these plate separations. The left hand halves representings obtained with sodium light in the laboratory, and the faint right-hand parts those with the night sky.

The latter show the coarse grain incortable (with present technology) in very fast plates, but it is evident that the ring systems are essentially just the same in both cases. When the two ring-systems are seen separately (Figure 2, left), those of one set are fainter than the other, both in the sky and the laboratory ---corresponding to the fact that $\lambda 5890$ is stronger than $\lambda 5896$

The agreement of the photographs makes it quite certain that the yellow radiation of the night sky actually comes from sodium

To obtain these interferometer photographs was a real tour de force. The light of other lines in the night sky spectrum had to be got rid of. The green line was cut out by an orange filter, the ted line by using plates not sensitive in this region. To obtain clear photographs from the night sky exposures had to be made on two or three successive nights. At the beginning of dawn (or at a corresponding hour in the evening) the radiations are much stronger, and exposures of half an hour suffice Figure 2 represents photographs taken in this light The longer exposures during the night gave substantially the same result. The intensity of the yellow lines is greater at low altitudes in the sky than near the zenith, obviously because we are looking through a greater thickness of faintly luminous atmosphere in the second case. If radiation comes from a fairly thin layer at a definite height above the ground, this effect will be greater, the less the height. It is obvious

from Figure 3 that the line of sight cuts the upper layer less obliquely.

From measures made by Garrigue, our authors conclude that the height of the luminescent layer is about 130 kilometers, or 80 miles.

This beautiful piece of work shows conclusively that sodium atoms are present in the upper regions of the Earth's atmosphere in sufficient abundance to give out their characteristic radiation. This is a very extraordinary fact, for there are also oxygen atoms up there, as well as molecules, and a free sodium atom would seem to have little better chance of long life than Billy Sunday's famous "celluloid dog chasing an ashestos cat through Hell." At present we can only say that they evidently do last long enough to do a good bit of shining. In the regions exposed to sunlight these free atoms cannot help absorbing energy from sunlight, and unloading it again, giving the characteristic "resonance emissions" The sunlight which they are absorbing is represented by the centers of the observed sodnim lines, and is much weakened, but still pretty strong, so that it is easy to see why these lines show so strongly at dawn. In the middle of the night they may be excited by impacts of electrons or ions--which are known to be present at this height.

BUT how do the sodium atoms get there? It is imaginable that some minute amount of salt dust derived from ocean spray may get a few miles up but if it did get 80 miles high, we would have molecules of NaCl, and no known way of decomposing them.

Our authors think it probable that the sodium comes from meteorites, which ecitainly contain sodium and are volatilized, in great numbers, at about this height. While the meteor is luminous it is very hot; and it is reasonable enough to suppose that free sodium atoms may escape from the turmoil.

If this explanation is correct, there should be free calcium atoms present, too,-and our French colleagues note that a faint line in the night sky spectrum at $\lambda 4226$ coincides, within the er-101s of measurement, with the resonance line of calcium. The meteorites should also liberate atoms of aluminum, potassium, iron, magnesium and silicon; but the resonance lines of the last two are out of reach in the ultra-violet-obscured by ozone absorption. Those of iron and aluminum are in the accessible portion of the ultra-violet, and therefore might be detected by observation in this region. The potassium lines are in the deep red, and might be disentangled from the strong bands there. Further studies which are being made in this promising field will be of great interest .- Princeton University Observatory, December 5, 1938,

American Archeologists

Agoia of Athens, conducted by the American School of Classical Studies, have resulted in uncovering the greater part of the ancient market place. Where 360 modern houses stood in 1931, and narrow streets were teeming with thousands of local residents, there now appear the public buildings and the broad streets which were frequented for hundreds of years by Athenians of the classical period. Since the level of the terrain of that age lies between 10 and 15 feet below the modern level it has been necessary to remove 190,000 tons.

Athens was subjected several times in its history to thorough devastation by invading armies: by the Persians in 480

quired to be filled.

of earth, which have been carted to the outskirts of the city where low land re-

Recent Results of the Excavation of the Agora, Market Place and Civic Center of Ancient Athens, Have Exceeded All the Previous Expectations

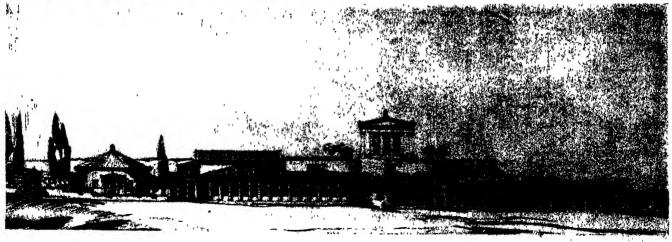
B.C., by the Romans under Sulla in 86 B.C., by the Herulians in 267 A.D., and by the Goths under Alaric in 396 A.D. Moreover, the site of the city has been almost continuously occupied from ancient to modern times. The result is that the remains of the ancient buildings exist for the most part only in foundations, but in the débris from the various destructions lying about the foundations so many architectural pieces from the superstructures of the buildings have been recovered as to make it possible to reconstruct the buildings on paper with practical certainty

The identifications of the public buildings are based on references to them by ancient writers, among whom the most valuable is Pausanias, a traveler who visited Athens about the middle of the second century after Christ. Although Pausanias did not aim to write a guide book, his description is so lucid that the excavated buildings can be exactly equated with those listed seriatim in his timerary. We can thus follow in the visitor's footsteps along the street bordering the west side of the market and see the Portico of Zeus, where occurred the diverting colloquy on feminine beauty be-

tween Socrates and Ischomachos, the small Ionic temple of Apollo, the Temple of the Mother of the Gods, where the archives of the city were filed and in the court of which the cask of Diogenes lay, the Senate House, and finally the Tholos, a circular building where the officers of the Council were boarded and distinguished foreigners were entertained. Towering on a hillock above these ruins is the best preserved of



At left: A fraction of the excavations; Temple of Hephaestus. Below, left to right: Tholos, Temple of the Mother of the Gods, behind it the roof of the Senate House, a stair leading to Temple of Hephaestus, the Temple of Apollo, the Stoa of Zeus Eleutherius



IN ANCIENT ATHENS

By T. LESLIE SHEAR

Professor of Classical Archeology at Princeton University Field Director of the American School of Classical Studies



The vase mending room mentioned in the text, with thousands of potsherds, or fragments of broken vessels, spread out on the tables in systematic order

all Greek temples, which has now been proved to have been dedicated to Hephaestus, the God of the forge.

Still following the route of Pausanias we then pass to the Temple of Ares, north of which is the Altar of the Twelve Gods, the most sacred altar in the market place; in the center of the area is the Odeum, in the southwest corner the main fountain house of the city and along the east side runs a broad street, 30 feet wide, which for centuries was the chief thoroughfare from the Agora to the Acropolis, providing an easy ascent for the great Panathenaic procession which regularly paused half up the slope at the site of the Eleusinion.

Thus the topography of the market place, as it appeared in the classical period, has been almost completely revealed, but in addition to that the excavations have uncovered earlier buildings and monuments which were unknown to the classical Greeks and have brought to light a long series of subsequent settlements. Substantial remains have been found of continuous occupation of the site extending with little interruption from the late neolithic age, about 3000 B.C., down to modern times. In order to determine the relative ages of successive deposits the utmost care must be exercised in the observation and excavation of furserous superimposed strata, and the objects found in them, by which the

chronology is fixed, must be accurately identified and precisely recorded. To this end a group of expert excavators has been developed in the Agora work and an elaborate system of recording has been established by which any one of the 38,000 catalogued objects from any designated square meter of the site at any stated level is immediately available.

BEFORE the beginning of these excavations it had been generally prophested that, because of the thorough devastation of the area, little of other than topographical and historical interest would be found except inscribed records which, being on stone, would not have been coveted by invading conquerors. The epigraphical haivest has, in fact, exceeded all expectations. The 5500 inscriptions so far found include part of the law code of Solon, the official list of the confiscated property of Alcibiades, other important legal documents, dedicatory inscriptions of various kinds, among which the most important are the epigrams of Simonides and Aeschylus in honor of the Athenians who fell at Marathon, and the epigram by Simonides written on the base of the statues of the Tyrannicides. Many honorary decree's which carry their date of issue have furnished much information in regard to names and dates of the archons of Athens, so that important additions and



Vase of late 6th Century, found in a well in center of the Tholos

corrections have been made to our knowledge of the Attic calendar. Not the least important of the inscribed documents is the collection of 289 ostraka, the ballots cast against citizens whom their fellows wished to drive into exile. The list includes the first and last men ostracized, Hipparchos, son of Charmos, in 487 B.C. and Hyperbolos, son of Antiphanes, in 417. The man on the list with the largest number of ballots (99) is Themistocles, and next to him comes Aristeides, "the Just," with 49 votes. These ballots are contemporary documents and, apart from their historical value, are of interest in illustrating the orthography of the average Athenian of the time.

A surprising result of the excavations is the discovery of sculptured works of both Greek and Roman periods and of quantities of vases, many of which are preserved in perfect condition. The unexpected sources of this material are early graves and wells, which were filled from time to time with débris, usually due to the clearance of the site after some disaster to the city. Since burials were not permitted within the city limits the graves antedate the period when the market place was here located. Scattered graves have been found with their contents intact which date from the late neolithic period, about 3000 BC., from the Mycenaean, 1200 B c., and from the protogeometric age, 900 B.c. Besides these a family burial plot, located just south of the later Tholos, was uncovered which dates from late geometric times (8th Century B.c.). The plot contained chaft graves for adults and urn burials for infants; its homogeneous nature was indicated by the proximity of the burials and by the fact that the area was surrounded by a circuit wall. Moreover, a detailed anthropological investigation of the skeletal material revealed a strong family resemblance among the occupants of the graves. The graves, which were intact with their stone covers in place, yielded many handsome complete vases of the period, one burial, that of a young girl, containing no less than 28 objects. This plot had been completely covered by the beginning of the 5th Century and its existence was presumably then unknown. It is evident that these



Vase of early 6th Century found in a well, showing oriental influence

graves have been preserved only by accident and that many other burials in the area were destroyed when the rock was cleared for the massive foundations of later buildings.

The most fertile source for individual objects has been the deposit in welks These are invariably cut in the soft bedrock and extend down to varying depths, the deepest so far cleared having a depth of about 120 feet. A few of the wells have been used continuously to modern times, but most of them are filled to the top with earth and débris. In some cases the ancient diggers failed to strike water and abandoned the project, but usually water is encountered after a few yards of upper filling has been removed, and several times the inflow of water has been so great that a 24-hour schedule of bailing has been necessary in order to make possible the removal of the deposit. Some wells have been opened on the northern slope of the Acropolis and in the Agora itself but most of them served small houses and shops in the areas adjacent to the market place.

THE clearance of a well is a difficult technical problem since the diameter of the shaft rarely exceeds a yard and is offen less, and great care must be exercised in order to avoid breakage of fragile objects. A skilled workman of small size works in the shaft, using only his hands for digging when small objects are numerous in the earth. The water and earth are removed by metal buckets operated by a windlass, and the deposit is recorded at 50 centimeter levels, the strictest watch being kept for evidence of stratification. All earth from wells is

passed through a sieve at least once; that from the well containing the ivory statuette of Apollo Lykeios was sifted three times.

The wells were filled up at different periods, usually in connection with some devastation of the city, such as the Persian invasion or the sack of Sulla, It may have been fear of pollution that led surviving inhabitants to fill existing wells with débris and hew in the solid rock with considerable effort new ones nearby. Where wells have been in actual use complete vases, usually of undecorated household ware, are invariably found at the bottom where they have fallen from the hands of careless housemaids. But for the most part the pottery in the filling deposits is broken and these potsherds, sometimes exceeding a hundred baskets in quantity, are taken to the workrooms where, arranged in sequence of depth from the top to the bottom of the well, they are spread out on long tables. Then

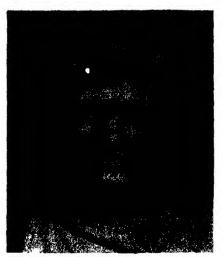


Staff members and technicians mending vases in the workrooms

members of the staff and the Greek technicians sort pieces belonging to individual vases which are put together, with restorations in plaster of any missing pieces.

Since the dates of the construction and of the filling of a well can usually be closely fixed by the pottery, lamps or coins on the respective levels, it is evident that invaluable chronological data are provided for other associated objects of which the exact period was previously unknown. If, for example, a piece of sculpture is found in a well which contains nothing later than the sack of Sulla. as occurred last season, that sculpture cannot be interpreted as a Roman copy of a Greek work, Similarly, in the case of undecorated household pottery and kitchen ware, which has been largely disregarded in the past, deposits of fixed date acquaint us with the domestic habits of the Athenians throughout the ages. A considerable amount of this plain pottery was secured in the last campaign from a well in the center of the later Tholos, which was constructed in the third quarter of the 6th Century and went out of use in 480. It was associated with handsome black-figured vases of the late 6th Century. This was the table ware which was undoubtedly used in connection with the service of meals in the Tholos to the officers of the Council.

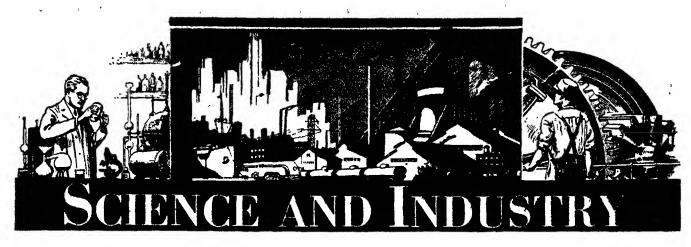
NOT a few pieces of sculpture have been secured from wells and in several cases where the pieces fit together to form complete statues it is clear that the objects were deliberately broken at the time they were thrown away. The most sensational discovery in the field was that of the unique ivory statuette of Apollo Lykeios which has been put together from 275 small pieces. A marble statue of a Faun was found broken in 73 pieces, and during the past season a statue of Hermes (see below) proved to be intact except for the right hand, after seven pieces had been cemented together. Occasionally the despoilers dumped an object into a well without taking the trouble to mar it, and then the excavators are cheered by the discovery of a handsome work such as the marble head of the bearded Hermes of archaic type, found also in the last campaign. This is a beautiful replica of the Hermes of Alcamenes, a sculptor who was active about the middle of the 5th Century B.c. Bronzes as well as marbles were tossed into the wells but, with several notable exceptions, they have suffered serious damage from the corrosive action of the water. The wells thus served as convenient dumping places for refuse, cast-offs, and any ob-



The head of the statue of Hermes which was found in a well in 1938

jects of which contemporary inhabitants wished to be rid, human nature being the same then as now; they have proved to be exhaustless mines of treasure to the excavators.

All the objects from the excavations are housed in a temporary museum on the site which will be replaced by a permanent Agora Museum, the construction of which will be begun in the ignorediate future. Full reports on the progress of the work and on the many discoveries are published in preliminary form in Hesperia, the Journal of the American School at Athens.



A MONTHLY DIGEST

LARGEST STEAM HAMMER

RAISING its steam cylinder-head higher than the average dwelling house, the largest steam drop hammer ever built has been shipped to England from the Eric Foundry Company This hammer will be used in the forging of airplane engine crankcases and airplane propellers for British aircraft of all types.

So light is the control that the ram may be brought within the smallest fraction of an inch of the dies at full speed and stopped there. The cushion effect of steam control was a marvelous sight to watch as the hammer underwent its preliminary test before being dismantled for shipment.

After installation, the hammer will be 27 feet in height, from the floor line to the top of the cylinder. Beneath the floor, extending 12 feet 9½ inches into the ground and resting upon its own foundation anchored to bedrock, extends the sub-anvil structure. This is in two pieces, each of which weighs approximately 234,000 poinds. The super-anvil, above the floor line and support-

From Sont to top 27 feet

War War I

Conducted by F. D. Mc HUGH

Contributing Editors ALEXANDER KLEMIN

In charge, Daniel Guggenheim School of Aeronautics, New York University

D. H KILLEFFER Chemical Engineer

ing the gigantic frames, is in two pieces, each of which weighs approximately 200,000 nounds.

The weight of the ram, piston rod, and piston is 50,000 pounds, and with the top die included, the reciprocating weight in creases to more than 70,000 pounds. The diameter of the cylinder is 39 inches and the stroke of the piston is 72 inches. The piston rod diameter is 11½ inches. The space between the guides is 50 inches and the ram is 80 inches front to back.

WINE FROM MILK

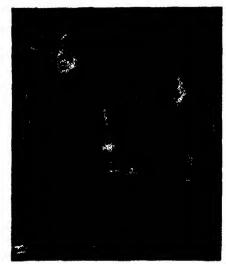
BECAUSE the great dairy industry in Denmark has whey as a by-product of its operations, carnest efforts have been made to find uses for the quantities of this liquid wasted. One of the latest results of these researches is the manufacture of an excellent "wine" from whey. So far only in the large-scale experimental stage, the process may yield as much as a million and a half Danish kroner annually, if results as proved to date can be realized on a nation-wide scale—D H. K.

X-RAY "CANDID CAMERA" SNAPS HUMAN CHEST

A SMALL glass "trigger tube," no larger tube, house current to work snapping a candid-camera picture of a human chest in less than a hundredth of a second.

This tube controls the flow of 110-volt power from a light-socket to a bank of condensers. Eight seconds later, at the press of a button, it releases this stored-up power as an 89,000-volt maximum discharge through an X-ray tube.

The resultant invisible X rays are shot out from the large tube and through the chest of a model standing four feet from the port-



Taking an X-ray snapshot

able machine. Cheking faster than a heart beat, this latest development in candid picture-making recorded a chest radiograph free from distortions which the movements of the heart sometimes cause in conven-

tional X-ray pictures.

Dr. Victor E. Hicks, director of the industrial division of the Westinghouse X-Ray Company, recently explained that the new condenser discharge dynex had been developed primarily for the study of chests in medical practice and listed its outstanding features as "the elimination of mechanical time switches, plus the uniformity of the chest films produced regardless of the chest thickness or line voltage variations."

The "trigger tube," Dr. Hicks continued, is a vacuum tube containing electric coils, which permits the power to flow from the electric outlet to the condensers and then when the coils become heated permits the condensers to discharge their accumulated power to make the X-ray exposure.

TINTED INSULATION BOARD

THE insulation board industry, whose first products were strictly utilitarian, has long been seeking to make its products decorative as well. The boards made of wood fibers, first a deep brown, have steadily been lightened in color, and are now available in a light tan.

One of the most spectacular advances,

318(11) 新以(173) 18 x 1 2



however, has come in recent months with the perfecting, by Fir-Tex engineers, of a tinting process. Fir-Tex "Colorkote" panels now are offered in ivory, sky blue, apple green, apricot, and shell pink. They provide interior wall finish, and insulation, in one application. Eliminated are lath, plaster.

wallpaper, and calcimine.

The basic board is made of interlaced wood fibers. The manufacturing process utilizes the by-products of Pacific Northwest lumbering-clean, inside wood which, for ordinary building purposes, is the wrong size or shape. The special Colorkote preparation, containing the desired tint, is mechanically painted on the board. In a battery of dry kilns, the tint preparation is baked in A calendering operation then produces a glazed surface.

Since the coloring material is insoluble in water, the Colorkote panels are washable. The home owner may change the color scheme at any time. Any decorating treatment may be used, and no sizing is required For novelty effects, the panels may be grooved to reveal the natural tan color be neath.

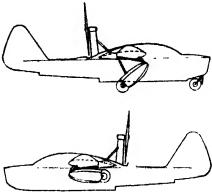
A NOVEL AMPHIBIAN

THE Spencer-Larsen Amphibian, which has been undergoing extensive tests on Long Island, has many novel and logical features in its design

In a pusher flying boat, the propeller thrust line must be well above the top of the hull, and so the heavy engine is likewise placed high above the hull. The center of gravity is high accordingly. But for stability in the water, the center of gravity should be low. The designers of the new amphibian have reconciled these divergent requirements by putting the engine in the hull and driving the propeller through a gear transmission unit, using two vertical shafts. If the welldesigned transmission system proves entirely serviceable, positioning the engine within the hull will bring other advantages such as the elimination of a drag-producing nacelle and greater efficiency of the pro-peller, which will be free of interferences. Of course the cooling of the internally placed engine must be carefully taken care of and suitable air scoops must be provided.

In former years, plywood was regarded with suspicion when employed in the hull. In the Spencer-Larsen machine, however, phenolic bonded plywood, internally protected with Bakelite varnish and externally with synthetic enamel, has resulted in a seaworthy hull which is easier and cheaper to

Above: The Spencer-Larsen amphibian. Below: Drawings showing how the stabilizing floats and landing wheels are combined and pivoted so the wheels may be retracted



build in limited production than a metal hull.

The amphibian characteristics have been attained by making the two stabilizing floats and the landing gear into single units. When the front end of each float is pivoted upward, the main wheels are in contact with the ground, and the nose wheel is let down. The boat is then provided with a perfectly serviceable landing gear. But when the nose of each float is depressed, the wheels are raised simultaneously and are faired in behind the floats. The photograph shows the general lines of the amphibian; the sketches illustrate the functioning of the combined water and land alighting gear.

With a four cylinder Menasco engine developing 125 horsepower, two occupants, and a useful load of 600 pounds, a respectable cruising speed is obtained. A small, not too expensive amphibian is not available on the market at the present time, and intelligent efforts to fill the gap will be welcomed by the aviation fraternity,-A. K.

CHAIRMAN OF THE C. A. A.

DERSONAL contact with Edward J. Noble. Chairman of the Civil Aeronautics Authority convinces us that here is the right man for an important job, Mr. Noble is not a career bureaucrat, not an over-zealous reformer, but a quiet, capable business man, with the most sincere desire to advince American aviation. He is modestly studying every phase of the many problems facing the Authority and coming to careful, wellthought-out decisions. Every announcement coming from the Authority in Washington bears out this view. Thus the solution of the vexing problem of a real airport for the capital of the country, and the elimination of the terrible flight hazards at the Washington airport, are both in sight. Plans are under way for a 750-acre airport at Gravelly Point on the Potomac River, only three and a half miles from the Washington Post Office. Four runways of at least 5000 feet each, good approaches, freedom from danger of flooding, and excellent navigational facilities are all to be provided. Again, the Civil Aeronautics Authority is not rushing into a program of airport construction for the whole country, but is undertaking a careful and comprehensive rational survey first of all .- A. K.

AUTOMATIC DIRECTION FINDER

FTER several months of intensive flight A testing in scheduled service with an American Air Lines Douglas transport plane, the Sperry Cyroscope Company has made public announcement of its new automatic direction finder. Since November, 1937, air regulations have required that all transport planes should be equipped with a shielded loop antenna and a direction finder to help locate the airplane and to secure positive radio reception of the airway beams under adverse weather conditions. Many excellent devices have been put into service and have proved of great utility.

The only drawback to these devices has been that they require close attention by the pilot, already burdened with other duties. The new direction finder not only achieves what previous devices have achieved, but functions automatically and continuously, to

the great relief of the airman.

With the automatic direction finder, the pilot is only required to tune to a station. The pointer on the dial of the instrument indicates the exac bearing of the station and continues to give the bearing even up to the point of passing over the station, Another valuable feature of the device is that it immediately shows the pilot when he has passed over a station, to confirm the "cone



The indicator of the automatic direct tion finder is conveniently local

of ellence" which he may have n flying on the regular radio beam silence is recognized at a sensor tive and, since, as the term implies a monichtary absence of any signal Another advantage of the sevent

that it provides a method of determ

defft or "crab" angle at any time. The pilot can tune in on a station toward which he is flying and observe whether or not the heading of the sirplane is constantly changing. If he then turns the airplane to right or left until the bearing is no longer changing, he can determine, by a simple arithmetical process, the angle of drift or "crab" that the plane must take to make allowance for the wind.

Still another advantage is that bearings can now be obtained when static conditions are so bad that it is virtually impossible to obtain a "null" signal if operating the ordinary type of hand-operated loop.

The instrument is so mounted as to have considerable appeal from the point of view of convenience. As our photograph indicates, the centrally located automatic direction finder is mounted in a horizontal plane. Following the pointer, the pilot can readily imagine what his course and bearings are over the earth below.

Some marvellous things have been done in demonstration. For example, the Douglas plane was able to locate a carefully hidden truck which was acting as a temporary transmitting station—A. K.

THE LIBRASCOPE

NE of the most important points in airplane operation is the correct balance or trim of the craft. Yet changes in cargo, consumption of fuel, changes in position of the passengers, all introduce changes in the trim. Minor variations in the center of gravity position may be taken care of by the use of tabs or trimmers placed at the rear edges of the elevators. But the tabs must not be asked to do too much or else both efficiency and control power are lost. Also, it is far better to know the location of the center of gravity at all times, so that necessary adjustments in weight position can be readily made. Formerly the operating personnel was provided with elaborate loading charts, and had to carry out complex computations.

Now the job has been taken over by the Librascope, made by the Meredith Instrument Company, which has no friction devices or springs to wear or deteriorate and carries on its lower face a number of dials which indicate (as our photograph shows) landing gear position, the amount of oil and fuel in the tanks, ballast, passenger loads in various seats, cargo load, and so on. By moving the various knobs appropriately, and setting



A seaplane on the Friesenland's catapult

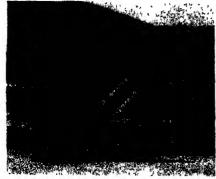
the weight adjustment to work, the operator can read the total weight on the scale at the upper left hand corner. A change over to "balance adjustment" indicates the center of gravity position on the right upper scale. We have operated the instrument our-elves at Newark Airport, and have been satisfied that here is a simple, entirely practical, and highly useful device.—A K

CATAPULTING A LARGE SEAPLANE

THERE are many plans for commercial THERE are many plant to the operation across the North Atlantic: the composite seaplane, the construction of a seadrome in mid-Atlantic, the use of a very fast, very clean landplane; the utilization of large flying boats with stopping places at the Bermudas or the Azores; the catapulting of heavily loaded seaplanes. We believe that the final solution will be in the construction of very large flying boats which will be able to fly non-stop from New York to London. while carrying a commercial payload. But in the intermediate stage, the catapulting of a large seaplane from a mother surface vessel, as practiced by the Deutsche Lufthansa, is an effective and successful method of operation. Recently the writer of these notes had the privilege of visiting the Friesenland, a surface vessel which is employed in catapulting the Lufthansa's seaplanes, and of observing the launching process. German engineers have worked out the catapulting system in good fashion. An air compressor, electrically driven, supplies air to huge cylinders with slow moving pistons. The irresistible power of the pistons, acting through sheaves and cables, sets the carriage into rapid motion without perceptible effort. The plane moves over the onlooker's head and in a couple of seconds the huge seaplane is aloft and away. Even the most blasé spectator gets a thrill when witnessing this triumph of the mechanical engineer's art —A, K

TORTURING THE LANDING

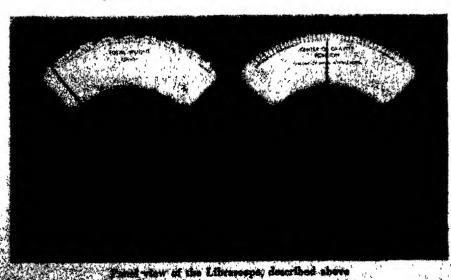
IN sirplane construction the ships are subjected to severe loading tests, to destruction if necessary, but it is not possible to submit them to quite the same degree of



Landing gear torture unit

rough testing as is done with automobilesthe hazard to pilots would be too great. Nevertheless, aeronautical engineers are rapidly developing a technique which will give guarantee of strength and safety in the completed ship. Thus, Lockheed Aircraft has recently introduced a piece of test equipment for landing gears which is a decided addition to this art of destructive or preventive testing. The three-wheel landing gear, of the tricycle or nose wheel type, is towed behind a car. On the three wheels is mounted a rather fantastic looking structure, on which the brave test pilot takes his seat, and on which tons of pig iron can be distributed in various ways. The wheels are provided with airplane brakes. Here are some of the test methods which the engineers

While rolling along at 40 to 45 miles per





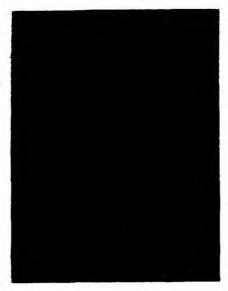
Above: Londspeakers in the belfry, and, right, the chime amplifier. The chimes themselves are concealed behind a set of dummy organ pipes

hour, the pilot suddenly locks one rear wheel brake. The three tons of steel framework and pig iron swerve sharply, rock, but do not turn over.

At the end of the runway a steel plate is placed on the ground It is about 12 feet long, ten feet wide and heavily greased so that it is as slippery as ice. The tow car reaches a very high speed, and releases the tricycle landing gear Just before the greased plate is reached. The pilot bounces the machine on the rough terrain, raises the front wheel and, while it is off the ground, turns it sidewise. On landing, then, it is in exactly the opposite position to that which all good landing wheels should assume for a proper landing. Violent "shimmy" is thus induced, and the pilot is subjecting the gear to the most severe test possible. The muchine bounces, jolts, and then to top off, skids onto the greated plate at 35 miles per hour. The front wheel swings around and the gear resumes normal operation, rolls ahead, and comes to a stop. That is to say, it should, if the designers have done a good job. Otherwise, the landing gear goes back to the experimental shop, and the pilot probably to the hospital!—A. K.

To Popularize Private Flying

RUMOR has it that the Civil Aeronautics Authority is seeking a method of stimulating private flying, but there is no inkling of the precise plan to be employed. In the meantime we have learned of the proposal of Alfred B. Bennett of the Bennett Air Service which has been well received in aviation circles. Mr. Bennett proposes that the Government should pay a student pilot \$50 when he solos and \$50 when he has had ten hours of solo flying. With the modest rates of flying instruction now available on Taylor Cubs and other low-priced aircraft,



the process of learning to fly would thus cost the young aviator practically nothing.

This plan would lead to an enormous increase in the number of student pilots. Thence would follow an equally large increase in the number of small airports, and an important increase in the construction and sale of low-priced airplanes.

In time of war there would be an enormous reservoir of pilots from whom to select the men capable of mastering the art of piloting a 300-mile-an hour pursuit plane. With the dangerous and continued unbalance of the Federal Budget, every responsible citizen is loath to suggest any scheme, however meritorious, which involves an increase of public expenditures. But of all the propounded pump priming plans this appears to be one of the most meritorious.—A. K.

EMPTY BELFRIES

A SYSTEM of amplified chimes installed in an eastern church appears to have solved the problem of the empty bell towers in American churches. This system utilizes

as its source a set of 21 standard tubular chimes such as those used by musicians. These are played from a small keyboard attached to the organ console and their sound is picked up by two microphones, placed for properly proportioned pick-up. These are standard crystal microphones and are fed into the mixing panel of a 250-watt amplifier developed for this service by Transformer Corporation of America. The heavy duty, horn-type loudspeakers, four of which are mounted in the bell tower, are fed through a low-impedance line and are capable of handling up to 160 watts output.

Centrally located in a city which has an area of approximately ten square miles, it has never been found necessary to operate the system at full capacity. In fact both the amplifier and the loudspeakers provide more than ample reserve to take care of the surges which are characteristic of the initial "hammer thump" of the chimes, a feature which received the special attention of engineers in the design of the amplifier.

So realistic is the sound reproduction of this system that only a handful of the populace is aware that the church tower does not house a genuine carillon consisting of massive bells.

This is one heretofore empty bell tower that has been utilized to the entire satisfaction of everyone concerned—and at a very small fraction of the expenditure that would have been involved for genuine bells

CORROSION PROOF

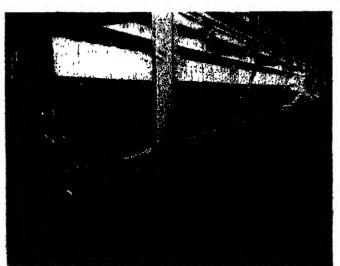
MORE than five tons of Monel nuts, bolts, and special studs are being used on the Fort Peck Dam project, North Dukota, as fusteners for valve seats and rings.

New Continuous Process for Propucing Rayon

A NEW continuous process for the production of rayon, still America's fastest growing textile fiber, recently went into large-scale commercial use with the opening of a huge plant by the Industrial Rayon Corporation at Painesville, Ohio. The plant will produce 12,000,000 pounds of complete ly processed rayon yarns per year.

Starting with cellulose sheets at the top,





Viscose ripening tanks and reel frames in the new continuous process rayon plant

the process finally winds completely finished rayon threads, ready for delivery to textile mills, on bobbins set low on the floor. Differing from conventional procedure, the rayon is not spun and wound on the bobbins immediately after being formed, but is bleached, shrunk, prepared, dried, and twisted before being wound.

Six years of research are represented in the plant, built at a cost of \$11,500,000. A pilot plant has been in operation successfully for two years. Fourteen acres of floor space have been provided in the buildings of the windowless air-conditioned plant. Daylight enters the factory through glass wall panels and monitors of glass block, 371,000 of which have been used in the factory, the laboratory, the power house, and auxiliary structures which, together, represent the largest glass block installation on record.

Special machinery for handling the rayon in this new fashion was developed by a subsidiary of the company. More exact conformation to specifications is one of the advantages claimed for the process.—Science Services

Non-Flood Device For Batteries

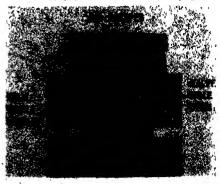
A NEW non-flood device for automobile storage batteries, to meet problems created by the modern practice of putting the battery under the hood, has been developed by engineers of The B. F. Goodrich Company. According to the manufacturer, a battery equipped with this device removes all fear that costly damage will come to engine parts through over-filling.

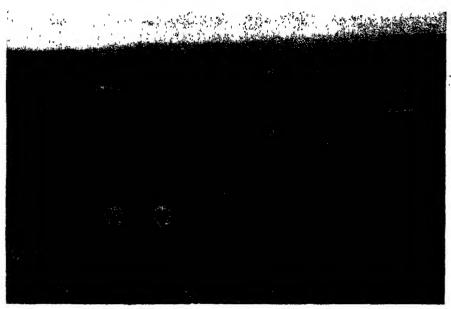
Three hard rubber parts—a barrel with two air vents, vent cap, and specially designed cell cover—make up the assembly. The barrel is screwed into the under side of each cell cover before the battery is assembled, a flange making it irremovable through the top of the cell cover when the battery is ready for service. A slotted top is provided in which the vent cap slides sidewise when being removed or replaced.

In operation, the barrel moves up when the vent cap is unscrewed and at the same time the two air vents located on each side of the barrel are closed, trapping air within the cell. As water is added, the air is forced to the top of the cell and when the electrolyte level reaches the bottom of the barrel, the air pocket beneath the cell cover prevents further addition of water.

At this point, scientifically determined, a small amount of water collects in the barrel, indicating that the safe filling level has

Below and right: New non-flood battery cap, showing how it works, as described in detail on this page





For carrying explosives to remote oil-field locations

been reached, with the non-flood device assuring sufficient space within the cell for the electrolyte to expand.

The barrel is firmly anchored, and holds the vent cap securely in place when the cap is screwed down. Air vents are opened, the trapped air escapes, and the water remaining in the barrel flows freely into the cell, without bringing the battery solution above the safe level

JUST WAVE THE MAGIC WAND

THE physics principle discovered by the scientist who rubbed a stick of amber with wool and made cat's fur stand on end is used as the operating force in an interesting toy airplane manufactured by The Mystoplane Company. Simply at the wave of a wand, tiny aliminum airplanes are made to remain in the air for several minutes, executing strange gyrations and flying formations.

The "Mystoplane" Set consists of a hard



rubber wand tipped with aluminum, a wool rubbing cloth, and a generous supply of tiny aluminum foil airplanes. The wand is rubbed with the cloth until a negative charge of electricity is stored up in the rubber, then one of the airplanes is touched with the wand, receiving a similar negative charge. Waving the wand then in the vicinity of the nirplane repels the tiny ship and causes it

to climb, dive, bank and turn, and behave like an actual airplane.

We predict that a lot of happy children are going to have a lot of fun watching Papa caper around the living room chasing a hunk of aluminum foil with a club.

TEN TIRES FLOAT OIL EXPLORERS

M AN makes earthquakes to order in the crude-oil explorations which grow more scientific every day. These earthquakes are set in motion by explosives, so their reflections from subterranean layers of prehistoric rock can be measured in nearly a dozen ways

Since the ancient rock formations that might pocket a hidden oil fortune occur as often under impassable Louisiana swamps as they do under the paved streets of Texas towns, man was compelled to devise a means to overcome marshy hazards.

These swamps were literally impassable to humans until swamp buggies, such as the Continental Oil Company explosives truck shown in our photograph, were built. This swamp buggy actually floats its weight of several tons over the "bottomless" mire on huge Firestone Ground Crip tires. Of course, the tires are kept at a low air pressure to cuslion the truck's testy cargo against jarring.

No More Exploding Cows

SOMETHING unusual in aluminum safety equipment is the Christiansen safety valve for cows. A rather common complaint of cows is too great indulgence in sifalfa, with the result that the cow becomes badly bloated and in danger of death.

The standard treatment for this condition has been to ram a pitchfork into the cow's ribs, puncturing the stomach and allowing the accumulated gas to escape. Since this is rather hard on the cow, Dr. P. J. Christiansen developed an aluminum safety valve with glass check ball, which is permanently inserted in the cow's side. A cow which beasts this latest piece of spare equipment can est



Mechanical carrier for harvesting pineapples

its way through a field of alfalfa, and except for a slight whistle of gas through the valve. suffer no ill effects.

The aluminum valve is light in weight and is not easily corroded by the weather and the escaping gas.

PINEAPPLE HARVESTERS

SE of 30 mechanical field fruit carriers during the 1938 harvesting season on the Hawaiian pineapple plantations of the Hawaiian Pineapple Company, Ltd., has convinced both workers and management that they effectively eliminate the most onerous feature of pineapple plantation employment.

Prior to the use of the machines, plantation workers gathered the picked fruit along each row and carried it in bags on their backs to the end of the row where it was placed in boxes to be loaded onto trucks. The mechanical carrier, moving under its own power, is now accompanied down the row by two loaders who need merely lift the previously picked pineapples from the tops of the plants and place them in one of the machine's two hoppers.

From the hoppers the fruit is fed automatically onto two elevators where the crown of each pineapple is cut off by a buzz saw. The elevators raise the pineapples to conveyors which carry them to the boxers. two of whom-one for each conveyor-stand with their supply of boxes between the conveyors, on the machine. At the end of the row the filled boxes are transferred directly from the carrier to motor trucks.

Motive power for the carriers is supplied by a Ford "60" motor, giving them a top speed of 10 miles an hour. The elevators and conveyors are powered from a separate two-horsepower engine

ACCURATE PICTURE RECORDS OF SALESMEN'S SAMPLES

MANY a business argument over substi-tutions or incorrectly filled orders can be avoided through use of a new Kodak Sample Record Outfit. Clear, accurate, detailed pictures of a salesman's sample can be made in a moment with this inexpensive, readily portable outfit-even by one who has not the least knowledge of photography. Regular snapshot film is used. Eight pictures-showing different samples or differ-

ent views of the sa on a 25-cent roll of film, Any photo finisher can develop this film, and prints cost but a few cents each.

Thus, the Sample Record Outfit provides perfect means for completing store records—accurately, easily, inexpensively and avoiding disagreements, ill-feeling, and time-consuming, profit-consuming correspondence when delivered merchandise does not correspond with the sample from which it was ordered.

The buyer places the salesman's sample inside the record outfit, slong with a card bearing the catalog number as stated. He then presses a light switch and touches a shutter button. It's as simple as that, and the result is a clear-cut, detailed picture of the sample actually shown. Nothing is left for argument or misunderstanding. The picture speaks for itself when compared with the delivered merchandise. And with this outfit, it's quicker to take a picture than to wait while a salesman writes out a long description.

Pictures taken with the Kodak Sample Record Outfit may be filed for use when reordering. More complete stock records may be kept, a picture of each article or style being attached to the proper inventory card. Any sample or object up to 61/2 inches high, 11% inches long, and 4% inches deep can be pictured.

FOOD

RAILWAY dining cars serve approximately 25 million meals a year, the equivalent to serving every inhabitant of a city of nearly 23,000 population with three meals a day for an entire year.

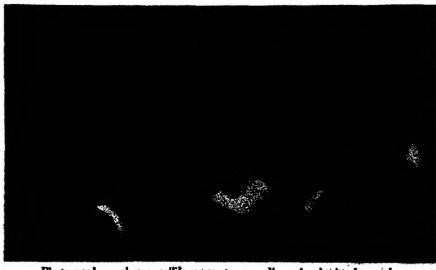
PUTTING "B. O." TO WORK

ODY odor is finding important industrial D applications quite aside from its func-tion as much advertised "B. O." in selling a particular brand of soap. Sebacic acid, important constituent of human sweat, is being synthesized and used in large quantities as an essential raw material in making softeners (plasticizers) for resin plastics and in making a new type of resin which yields a silklike fiber far superior to ordinary rayons. Caproic acid (normal hexoic acid), which bears a relation to the body odor of goats which is similar to that of sebacic acid to humans, is finding numerous important uses since its recent synthesis has made it an industrially available raw material.

No, the products made from these acids do not necessarily have the same odor. In fact, many of their industrially useful derivatives are odorless and still others actually possess pleasing fragrances.-D. H. K.

HANDS CAN CARRY DANGEROUS GERMS

OW clean are your hands? The "resident" flora of the arms and hands of Dr. Philip B. Price of Johns Hupkins University School of Medicine, und ordinary conditions, is second \$1 micro-organisms. Some of those are dis germs. But, in addition to these "o



Photography makes possible accurate recording of submitted samples

Bors. Dr. Price and yen and I have "transfest" form. When the hands are dirty, the transients are present in enormous numbers. The transients, however, are comparatively easy to remove or kill. Not so with the residents.

If the hands are in frequent contact with contaminated objects a dangerously large proportion of the resident bacteria may be pathogena. In such cases it is almost impossible to disinfect the hands. In this hitherto unsuspected manner a person may become a carrier of virulent disease organisms, according to Dr. Price.

After the long, elaborate, and painstaking scrubbing and disinfecting that the surgeon gives his hands before an operation, he succeeds in reducing the number of bacteria to around 200,000. Then he puts on sterile rubber gloves.

Dr. Price has tested various disinfectants with a view to use in preparing the surgeon's hands for an operation. A minimum of seven minutes with soap, warm water, and a good brush is needed to remove the transient bacteria and fats, gross dirt and, incidentally, about half of the resident flora.

Dr. Price has tested all the germicides in their effect on the resident bacteria. Some he finds good, some useless.—Science Service.

PRESERVING FINISHED LUMBER

STAIN and decay which attack wood are not entirely avoided by painting. Consequently many toxic materials have been suggested for use in treating wood for its preservation before painting. The Western Pine Association has recently conducted careful comparative tests of some 43 such wood preservatives. As a result of these studies, four of the compounds tested have been shown to be effective. Of these, pentachlorophenol, tetrachlorophenol, and 2-chloro-ophenylphenol are recommended for commercial use on lumber. A fourth compound, ortho-phenylphenol is also effective but at present is too expensive for commercial use. When dissolved in specified petroleum solvents and applied to finished millwork, these materials confer a high resistance to stain and decay over many years without interfering with painting or otherwise causing trouble in the normal use of the lumber.—D. H.K.

COLD LIGHT (LUCITE) SURGICAL INSTRUMENTS

A GROUP of surgical and dental instruments which concentrate light at any desired point, and piped illumination bringing a powerful, sterile beam of light into the operating room without heat or glare or danger of electrical shock, have heen made possible by Lucite (methylmethacrylate), the crystal-clear and practically unbreskable plastic developed in the laboratories of dis Pont. The faculty of this plastic, like quarts, of carrying light around curves, is primarily responsible for the adgaments of these instruments.

Among the energical instruments with qualities not proviously available is a tongue depressor, made from a curved Lucito rod, with formula light coming sat at the cad. In the cade of the





Two uses of piped cold light. Left: In dental work. Right: Transillumination of a sinus. Note the illuminated area visible just over the right eye of the patient

single instrument, the operator's hands are left more free, and the examination is simplified. The source of the light is a small electric bulb at the base of the plastic depressor, which receives its current either from a cord, transforming 110 volts to six volts, or from a flashlight base made for this especial purpose.

The tongue depressor gives a white and brilliant light, showing up the tissues in their truest color, because "Lucite" partially filters out the infra-red rays. Moreover, the light is cold, because Lucite is a nonconductor of heat—a comfort factor for the patient; and is shadowless because concentrated at the exact point desired. A laryngeal probe, designed principally for deep throat work, and useful in both diagnostic and operative piocedures, is another dual-rôle instrument, combining light and probe in one.

The double function and improved lighting qualities are also found in a group of retractors. These instruments are used to hold back the tissues while operating, affording the surgeon a clearer view and better access to the field of operation. In these new illuminated retractors, here again there is the advantage that the curved shape and the accurate focusing of the light rays give better illumination to the field of operation. Also the elimination to the total the curved shape and the accurate focusing of the light rays give better the field of operation. Also the elimination to the field of operation confort.

Transilluminators for various specific purposes, intended for diagnostic work—for example, the sinuses—are included in this series of instruments made by the Curvlite Sales Company.

POWER

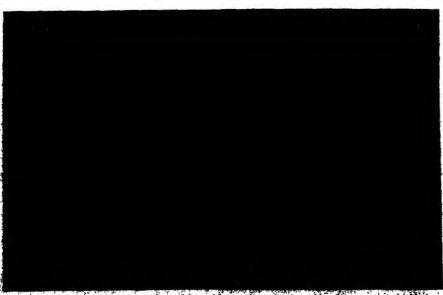
THE combined output of the first three generators now under construction for Grand Coulee Dam will equal 324,000,000 watts—enough electricity to light approximately 5,500,000 60-watt house lamps, or supply illumination to New York City and Chicago combined.

TRUCKVEYOR

NEW coal truck device which offers a clean, quick, and economical way to deliver coal by eliminating wheeling and shoveling and by reducing delivery coats, has been anounced by Gar Wood Industries, Inc.

The truckveyor, as this device is called, makes it possible for a truck to do the same work as a high-lift or double-elevating unit, such as chuting coal over long distances, into elevated bins and over terraces, and at the same time reducing the over-all height

150



Cent from track to bin without shouling or handling

1 4.

of the body as compared to a high-lift, eliminating excess weight, and permitting more pay load to be carried at considerably lower cost on the same size truck.

The truckveyor does not interfere with the use of the truck as an ordinary dump unit, when required, and it is not limited to coal deliveries, but may be used for other commodities as well.

The truckveyor consists of a strong, aluminum-alloy frame supporting a heavy-duty eight-inch rubber belt on two four inch aluminum pullevs, one at each end of the truckveyor. The drive pulley has a right-and left-hand gear box operated by a flexible shaft which is connected to the truck power take-off by means of an auxiliary shaft and universal joints. Hinged baffle plates and extension sides on the conveyor frame are provided to prevent spillage. When not in use, the truckveyor is carried in a compart ment built inside the body, or held on the outside by retaining brackets.

ACID PLANTS USE RARE METAL

TANTALUM, a relatively rate and an arrangement econ-ANTALUM, a relatively rate and expenomies in the manufacture of hydrochloric acid. Because the metal transmits heat readily and much heat is generated when hydrochloric acid gas is absorbed by water, absorbers huilt of tantalum are almost midgets compared with stoneware and fused silica plants which have previously been the rule. Tantalum is one of the very few metals which will resist the attack of hot hydrochloric acid, and, despite its high cost, plants built of it are more economical than ,old style plants. A single absorbing column six inches in diameter and a little over six feet long has a capacity of 3000 pounds of 20degree acid per hour.

This and other developments in the use of tantalum are encouraging the Belgians to develop rich deposits of its ores in Belgiam's tropical African colonies.—D. H. K.

Voice-Powered Portable Telephone

A PORTABLE telephone which gets its power solely from the speaker's voice and requires no external source of power



Inside the batteryless phone

was announced recently by the Western Electric Company. A measure of the new instrument's effectiveness is gained from the fact that it will, with an efficient telephone line, transmit speech over distances in excess of 200 miles.

The "magnetic" telephone, as the device

is known, was designed by Bell Telephone Laboratories primarily for use in such places as railroad yards, ships, coal mines, construction camps and similar locations where the need exists for simple, highly reliable, and portable communication facilities.

In size and shape the instrument resembles a child's building block and its secret of operation rests in a small, though power-



Voice-powered telephone that requires no battery. Hand crank is used only for calling the other party

ful, magnet. "Voice currents" are generated when the flux from this magnet is influenced by the motions of a metal diaphragm assembly vibrating under the impact of sound waves. An identical instrument at the receiving end acts in reverse order to reconvert the voice currents into intelligible speech counds. Each telephone is fitted with a small hand crank for generating a signalling tone. The "called party" hears a shrill, distinctive note, similar to that emitted by a fire siren, which is especially capable of penetrating through noise.

Protection against weather and mechanical injury is provided by a semi-hard rubber housing, and convenient connection with the telephone line, a matter of a few seconds, is made by means of a waterproof cord, the conductors of which terminate in spring clips.

PLANES

AMERICA'S aviation industry could triple its present production rate of 320 planes a month without greatly expanding its factory facilities. According to a Science Service writer, there is only one potential brake: the need for a far greater number of highly skilled tool makers than are now employed in the industry and who would require time for training.

A NEW MOLD MATERIAL

CIENTISTS working with limestone, coke, and salt scored a victory over nature in the development of Koroseal, a synthetic product possessing rubber-like properties. After being tested for over four years, Korogel, a soft variety of Koroseal, is now being recommended and used as a mold material for casting plaster of Paris, cement and concrete, artificial marble, and almost any kind of synthetic stone.

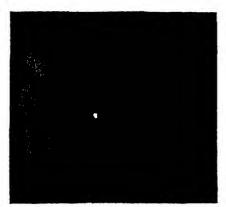
Korogel is not affected by water or the common materials found in casting shops. Molds made from it do not require any sizing or other treatments between casts. It is not affected by atmospheric conditions so

that the same composition may be used in winter and in summer. It does not dry out or deteriorate with age, allowing molds to be stored for indefinite periods of time and still be usable. Korogel does not shrink, expand, or distort in service. If handled with reasonable care, over a thousand casts may be taken from the same mold. Unlike rubber products which have been proposed for similar service, Korogel can be remelted and used over and over again.

Small lots of Korogel can be melted readily in an ordinary enameled household double boiler, using in the outer container a high boiling oil as the heating bath, and heating over a gas burner. Larger lots can be melted by adapting the double boiler principle to equipment of the required size or by using electric heaters especially designed for the job.

Having melted the material, it is allowed to stand without stirring or additional heating until it has cooled to the point where it will just flow freely. The model over which the mold is to be made is arranged in the usual manner with all high points of the shell or retainer fully vented. Obviously, for objects such as plaques and other simple pieces an open-back mold is satisfactory and a shell is optional. The Korogel is poured slowly until the space allotted is filled. After pouring, the mold is allowed to stand until cold. At such time the model is removed and the mold is ready for use.

Good Korogel molds can be obtained from models of wood, metal, glass, ordinary plas-



Molds of Korogel are pliable, can be removed from casting undercuts

ter of Paris, Hydrocal, metal casting plaster, Keene's cement, and almost any other rigid material which is not affected by temperatures of approximately 275 degrees, Fahrenheit.

A great deal of publicity has not been given Korogel thus far, the manufacturers and distributors preferring to carry on a conservative testing program with a few users. Adaptability to the service together with low operating costs is resulting in increased demands for the product.—S. L. Brous, B. F. Goodrich Company.

COLORED LIGHT FOR MOTOR CAR HEADLIGHTS

ANY thousands of motorists use headlights giving a colored light in the helief that they possess advantages over white light of the same power for driving at night or in fog. It is claimed that with colored light, objects on the road are more easily seen, that glare is reduced, and that the colored rays penetrate farther into mist or fog.

Legislation in France compelling the use of headlights emitting yellow light has served to focus attention on this problem, investigation of which was undertaken by the British Medical Association. The Association reported that extravagant claims had been made for yellow headlights, and that no definite recommendations could be made in any direction.

It is emphasized that, in deciding upon the relative merits of white light and colored light, it is of great importance to note that when colored glass is put in front of a lamp it not only colors the light, but also reduces its brightness. False conclusions are often drawn through failure to separate the effects of change of color from reduction of brightness.

None of the claims made in favor of using a colored headlight beam, yellow in particular, rather than a white beam of the same power, has been substantiated. The claim for a greater range of visibility in fog may be regarded as definitely disproved. As for the other claims of less glare and greater facility of vision, the evidence is inconclusive, but it is apparent from the information at present available that no considerable advantage can be secured by using colored light.

ROTATING RECORD SYSTEMS

T WO new and economical record systems that promise to make the office a new source of profits through savings in low cost of housing, increased volume of work per



Revolving card index wheel that shows the entire face of any card

operator and decreased amount of floor space required, have just been announced by the Diebold Safe & Lock Company.

Years of laboratory and field research, including careful analysis and study of test installations under all kinds of operating conditions, brought to light the following as the desirable objectives for card filing systems: Systems should bring the cards to one common position for reading or posting; The entire face of each card should be in readable position; Both sides of the card should be quickly available; All reference and posting work should be done at one position—desk bright; All reaching and stretching motions should be eliminated in order to avoid undirections the operator.

Both Cardineer and Reveldex Filing Systems have been designed to afford these every-day working advantages. They have made practical the application of rotation to record systems—rotation that brings every card to one common reading and writing position.

The Cardincer is a molded plastic wheel, housed in either a metal cabinet or supported



Another type of index wheel that greatly simplifies clerical card work

on a stand. It is available in different diameters for housing from 1500 to 6000 cards and will take care of cards five, six, and eight inches wide. The cards are threaded on metal bars through slotted holes punched in the bottom of the cards, the bars being attached to the wheel by means of a patented locking device. For check or stamp posting, the cards need not be removed from the wheel If they are to be posted by hand or machine, they are readily removed from the wheel with one hand, posted and returned with little effort.

Reveldex wheels revolve in a horizontal plane instead of the vertical plane in which the Cardineer wheel revolves, Reveldex cards are held at two points instead of one and are intended as reference records whereas Cardineer may be used for both reference and posting records.

FERTILIZER SAVES BEETS

CROWERS of sugar beets and refiners of sugar from them have suffered heavy losses from rotting of the vegetables in storage piles. Recent experiments have shown that fertilizing growing beets with phosphates not only increases yield but at the same time makes them substantially more resistant to rotting. Beets grown on soil deficient in phosphate are reported to rot three to five times as fast as those properly fertilized.—D. H. K.

Man No Newcomer in America

BELIEF that primitive man lived in Florida at the close of the Ice Age, from 10,000 to 15,000 years ago, hunting the mastodon, elephant and saher-toothed tiger, has received fresh confirmation from investigations conducted by Dr. H. G. Richards of the New Jersey State Museum.

In a report made public by the Geological Society of America, Dr. Richards states that he revisited the site of Vero Beach on the eastern shore of Florida, where parts of three human skeletons, associated with bones of animals, including many extinct species, as well as hunting implements of flint and hone, were discovered in the bank of a drainage canal more than 20 years ago. Among anthropologists these finds have been the subject of years of lively dispute

Since the human remains were found only, a few feet below the surface some geologists suggest that they represent a burial that took place relatively late in geologic time, Others, arguing from the undisturbed condition of the layers of rock above, and from chemical analyses of the human and animal remains which revealed similar changes in mineral content, maintain that the human remains were contemporaneous with the remains of extinct animals which are known to be of

Pleistocene age.

Dr. Richards's findings support the latter view. He examined the layers of sand and sandstone in which the remains were found, as well as the overlying and underlying beds of shell, marl, muck, and limestone. The older or underlying beds, he states, were laid down in periods when the Ice Age glaciers receded temporarily from northern latitudes, melting and feeding the seas, which then grew in depth and covered the coastal plain

of Florida.

Dr. Richards found that, during the Ice Age, Florida's climate fluctuated much as did the climates in more northern latitudes. When ice sheets receded in the north, the climate was at least as warm as that of today, and when they advanced the climate was much cooler.



Stainless-steel cooking utensils that are good-looking enough to be used on the table are a new labor-saving device for the housewife. The one shown is a baking dish that came direct from the oven to the table

STARCH FROM SWEET POTATOES

MANUFACTURE of high grade starch from sweet potatoes grown on cut-over pine land in the South has proved commercially successful on a scale of production of 15 tons per day. The project seems to offer promise in the agricultural rehabilitation of the southern states by providing a prolific crop with a ready sale to supplement cotton and tobacco as cash crops.

Yields as high as 500-600 bushels per acre have been realized in experimental plantings of selected varieties of sweet potatoes in southern Mississippi where this industry has been started. Average yields from many plantings over a period of several years have run as high as 300 bushels per acre. These compare with a general average yield of sweet potatoes of 78 bushels per acre in the

United States. Selection of variety of plants and care of the crop account for the difference.

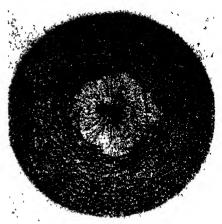
The starch manufacturing process is similar to that used in Europe and in Maine employing white potatoes as raw material but is modified to meet conditions. [See also page 280, May, 1938, Scientific American.—
Editor.]

Development of the agricultural aspects of the sweet potato crop—it has not heretofore been a large-scale farm product—is being pushed to make it fully profitable to the grower since the feasibility of the project has been demonstrated—D H K

How Fast Does Glass Break?

WHEN glass breaks the cracks move at the amazing speed of nearly a mile a second or more than 3000 miles an hour. The speed of cracks, knowledge of which may lead to stronger and safer glass, was accurately timed by high-speed photographic research at the Massachusetts Institute of Technology.

The accompanying stop-motion photograph, made at an exposure of less than one-millionth of a second by Graduate Student Frederick E. Barstow and Professor Harold E. Edgerton, shows cracks radiating from the center of a piece of tempered glass and the formation of lateral cracks at the instant it was struck by a metal plunger, the dark spot at the center of the picture. Observe



High-speed stop-motion photograph that shows how cracks form in glass

that the pattern of the cracks forms a perfect circle, visual proof that all cracks grow at the same velocity. Radial cracks appear to move outward, while lateral fractures seem to move inward.

PHEASANT-CHICKEN Hybrid

AFTER five years of experiment, the members of the Science Department of Avon Old Farms, a college preparatory school at Avon, Connecticut, have finally succeeded in crossing a pheasant cock and a game hen. So far as is known, this is the first time this has been done. The boys found that the secret lies in mating the birds in the fall rather than in the spring.

The hybrid shows many chicken and pheasant characteristics. Both sexes seem to possess the red eye ring of the male pheasant. A ring is present around the neck of the birds similar to that of the Ringneck male but black in color instead of white. Plumage is markedly chicken in banding and color.

The boys who successfully conducted this experiment are 12 to 14 years old and are members of the first two forms of the school.



Newly developed, Hastolite Bakelite resin coating for metals protected one side of this panel during a two-year test exposure to gasoline, hot salt water, and moist air. The coating still retains its gloss. Picture at



right shows that the unprotected surface of the same test panel is severely corroded

HYDROGENATED ROSIN

COMMON pine rosin, which contains the cheapest organic acid and whose industrial usefulness has been limited by its tendency to oxidize and discolor in use, has emerged from the process of hydrogenation as a virtually rejuvenated raw material. Treatment with hydrogen in the presence of a suitable catalyst improves the color of low-grade rosin until it is whiter than even the highest present grades. At the same time a change in the character of the rosin is produced which prevents it from discoloring in sunlight. This process, which is covered by patents, is expected to enlarge the usefulness of rosin materially.—D. H. K.

V-8 Engines Get Novel Task

MONG the more unusual tasks performed by automobile engines should be listed that of four V-8s in the Ford Motor Company's new tire plant. The engines are operated for the exhaust gas they produce, and the power they make in the process is utilized to compress the gas.

While at first glance this arrangement might seem to be an example of industrial bootstrap lifting, it actually is the solution of a problem found in "curing" tires.

The curing process is one in which the tire, with a heavy rubber tube or curing bag inside, is placed in a mold and subjected to heat and pressure. This forms the tread and makes the tire tough and durable. As formerly done, steam was first shot into the curing bag under high pressure, then it was drawn off and replaced by compressed air. The method was entirely successful, but there was one drawback: because of the

great heat and pressure the oxygen in the air caused the rubber curing bags to deteriorate too rapidly.

Tire engineers decided that using an inert gas, one containing no oxygen, instead of compressed air, would solve this problem. However, to buy enough inert gas for a busy tire plant would be expensive, and so they worked out the plan to make the gas with Ford V-8 engines, with the engines at the same time driving compressors to put the gas under the high pressure required.

Running at a fixed speed, the four V-8 engines on the job produce about 14,500 cubic feet of exhaust gas an hour, which is precisely the amount the four compressors are able to handle. The exhaust gas is piped from the engines through a series of cleaning and filtering devices, and then goes into the compressors as harmless carbon dioxide and nitrogen. The compressors raise the pressure to 450 pounds per square inch, and send the gas on to the curing molds.

ULTRA-SHORT RADIO WAVES BEND

THE dream of using ultra-short radio waves as secret signalling means during wartime is receiving little encouragement from experiments undertaken at California Institute of Technology, indicating that such waves—believed at first to travel solely in line-of-sight fashion—really can bend around the surface of the earth.

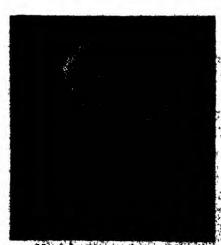
Prof. G. W. Potapenko and Dr. Paul S. Epstein of the Institute have recently completed preliminary studies showing that waves of five meters and one meter length can be picked up at a distance of 18 miles at sea.—Science Service.

MILK BOTTLE HOOD

A NEW milk bottle hood that combines a pure aluminum hand-seal and water-proof transparent window has recently been introduced in the dairy industry by Reynolds Metals Company.

The new "windoscal" is a pre-formed metal cap that completely covers the top and clamps under the lip of the milk bottle. The transparent window permits visibility of the regular printed paper plug.

Advantages of the new metal hood include: Elimination of stock of printed, predated hoods; elimination of preparatory and printing costs; and elimination of printing and embossing wearing away under icing



Metal battle cap with scholes

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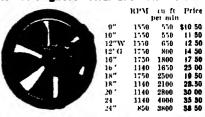
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NATURAL GAS STORAGE

THE storage of surplus natural gas in depleted gas sands during periods of low consumption is an important conservation measure, and a boon to distributing companies. Most of these companies procure their gas both from natural gas reservoirs and by purchase of gas that is a by-product of oil production and natural gasoline extraction. Due to the use of natural gas for heating, the greatest demand for it is during the winter, while the greatest supply of the by-product is available during the summer, frequently at a relatively low cost. Stored at low cost in underground reservoirs favorably located with relation to large markets, it reduces the load on long transmission line systems during periods of peak demand and may obviate the need for heavy investment in new pipe lines.

Practically 100 percent of the gas stored in an exhausted field may be recovered if the field is protected against offset drilling, if the formation is impervious to leakage, and if the old wells are tightly sealed.

Early in 1936, Oklahoma Natural Gas Company examined a small field in Tulsa County from which most of the gas had been exhausted. The original rock pressure in this pool had been 560 pounds per square inch. Several paying wells had been drilled and approximately 500,000 cubic feet of gas had been removed from the field before the pressure had declined to about 100 pounds per square inch. A series of dry holes showed that the pool was geologically closed and defined the limits of the pool which covered an area of nearly 160 acres.

In order that the entire area occupied by this reservoir might be covered by contract, the Company secured storage rights upon approximately 360 acres. In addition, a regular five-year commercial oil and gas lease was executed. The gas remaining in the reservoir that could be removed if the pressure were reduced to 50 pounds per square inch was calculated and the owners reimbursed. After the necessary rights had been acquired, all the abandoned wells were checked for proper plugging, and two wells were left for the purpose of introducing and later extracting gas. During the summer of 1937, gas which could be bought at a low price from gasoline extraction plants was injected into the depleted sands with the aid of a compressor. The reservoir was died rather slowly in order that elservations all the resulting pressure could be carefully noted. Approximately 77,000,000 cubic feet of gas was injected into the reservoir and the preseure increased to 232 points per

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square inch. Starting some two months later, during the winter months, withdrawals were made in accordance with market demands in Tulsa. By the end of the winter nearly 79,623,000 cubic feet had been withdrawn, about 2,500,000 cubic feet in excess of input, and the pressure of the reservoir still was 50 pounds per square inch above the pressure at the time the injection of gas was begun. The reason for this increase in pressure is not known exactly, but it may be due to eheroschment of water in the reservoir space sometime after starting the injection of gas.

Due to the fact that a relatively small amount of equipment was necessary to handle the gas, and no great expense was involved in securing the storage rights and placing the wells in condition, the total cost per 1000 cubic feet for storing and extracting this gas was below the standard field price in this area .- Stone & Webster Bulle-

RADIO TROUBLE-SHOOTER

ELECTRICAL communication has become a vital part of modern livingon sea and land, in business and in the home The transmitting and receiving apparatus has reached a high state of development, but since it is machinery, the fact is recognized that it might get out of order. Hence one of the major problems encountered in the communication field is to repair the break down when it occurs. Naturally, this must be done quickly and accurately

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and receivers, public-address systems, and other devices in which vacuum tubes are used, has been made possible by the Rider Chanalyst. Heretofore, trouble-shooting methods have been based upon testing the static condition of individual components of the device, upon operating voltages, continuity checks, and the like, but these methods were uncertain and time-consuming. With this new instrument, it is possible to determine how different circuits are functioning without disturbing the performance of the apparatus as a whole and when that portion of the unit is found in which the signal departs from normal, the cause of the trouble is sought in that particular location with such secondary tests as those mentioned above.

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PLAYGROUNDS IN THE AIR FOR EVERYONE!

THE "City of Tomorrow," recently displayed in New York, proposed that sidewalks of the future be covered with "bouncing," resilient materials to reduce walking fatigue and to deaden the noise of millions of moving feet

This idea is by no means new. Shockabsorbing surfaces for outside walking and other activities-decks, walks. and roofshave long been sought. It has been realized that the development of a suitable resilient material would permit the wholesale conversion of acres of flat city roofs into recreational areas, open to the sun and safe from traffic in the streets below

The recent development by engineers of The Celotex Corporation of a resilient wearing surface for exterior use is aimed at this problem After a long series of tests, the material has now come into practical use under the appropriate name of "Promenade Traffic Top.

Traffic Top is a bagasse fiber board impregnated with selected bitumens by a special process. This board, left naturally black, or coated with an elastic color finish, may be bonded to any rigid base, it is claimed When used as a roof surfacing, it may be applied directly upon the built-up membrane of the roof. When used on a walk or ramp. its manufacturers recommend that it be cemented directly to the concrete, wood, or composition base The cement used should be either a hot brushed-on asphalt, or a cold asphalt adhesive that has been prepared expressly for this purpose by the makers of the board.

Good traction is claimed for the board, even when wet. For this reason, it is recommended as a promenade surface around swimming pools, or wherever there is a continually wet condition. All exposed surfaces subject to foot or light wheeled traffic may be covered with it. A concrete tennis court, for example, when covered with green Traffic Top, has much the "give' and the color of a real lawn court.

Playgrounds, roof tops, courts, and pedestrian approaches in schools, hospitals, apartments, office buildings, hotels, and residences may be advantageously covered with it. It makes an ideal surface for residential play roofs, since it will reduce transmission of noise of moving feet to the rooms below. It is light in weight-lighter, in fact, than a conventional slag roof-and requires no extra supporting construction.

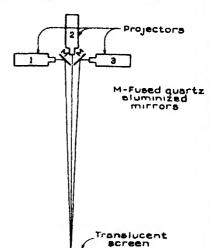
FUSED QUARTZ SOLVES COLOR MOVIE PROBLEM

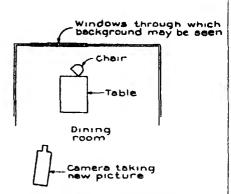
LEAR fused quartz, a product of General Electric's Thomson research laboratory at Lynn, Massachusetts, has been given an exceptional assignment in the mo-

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tion picture industry. It has solved a problem that arose with natural-color pictures and, as a result, a feature movie, soon to be shown, will have a scene depicting an old southern gentleman arguing with his negro servant about some pork chops, while through the dining room windows can be seen several thoroughbred horses grazing peacefully in a heautiful green Kentucky meadow.

The dining room in question is on a Los Angeles motion picture stage. Outside





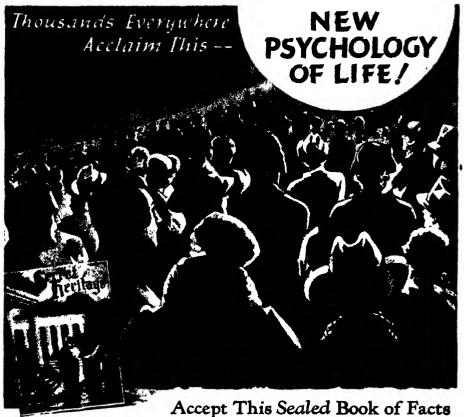
How three projectors were used recently to produce u "composite" shot in a new color motion picture

the windows is a translucent screen called a "transparent" by the film folk. The meadow and horses are projected on this screen from the back, with a motion picture projector, and appear as natural as nature from the front side through the dining room windows.

In the days of "black and white" pictures this was simple. The camera taking the new picture and the machine projecting the background were driven by synchronized selsyn motors so that no flicker could be seen on the background in the new picture.

Then came color, and the technique was changed overnight. The amount of light required to take a picture in natural colors was two or more times greater than that required for black and white. It simply was not possible to get enough light from one projection machine for the average size background in color and in motion.

As a matter of fact, three projectors are required, and they must operate in exact synchronism, and in synchronism with the camera taking the new picture. This part was easy, for selsyn motors took care of that. But to make the projected image clear and than, the three cameras must project from



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very nearly the same point, much nearer the same point than their physical size would permit.

This was solved by having one camera shoot directly at the screen from a point directly away from its center. The other two project against mirrors set at 45-degree angles. This may be understood clearly by referring to the sketch. The mirrors are so placed that, standing directly in front of one of the projectors and looking into its lens, the lenses of the three projectors appear to be equally spaced about an imaginary circle whose diameter is scarcely greater than the diameter of one of the lenses.

Because of the intense heat, ordinary silvered glass mirrors could not be used, so General Electric supplied aluminized fused quartz plates, accurately ground to $\frac{1}{2}$ wavelength. The silvered glass reflectors first tried required refinishing after a few hours of use, the fused quartz mirrors have operated month after month with complete satisfaction

New Element (?)

GERMAN research workers report a hitherto unknown product of radioactive transformation which may be a new element. The properties of the material suggest that it is eka-indium with an atomic number of 95. Previously it has been generally agreed among chemists that there could not reason ably be more than 92 elements and that there was no use searching for others since all 92 are known. Perhaps, as this suggests, there are new elements yet to be found.—D H. K.

IF YOU FIND A METEORITE

THERL may be "stones from Heaven" in your doorvard. If so, the Smithsonian Institution, at Weshington, D. C., would like to add them to its collection. Scores of supposed meteorites are sent to the Smithsonian experts for identification. Usually they are almost exactly the opposite of what a meteor really is, due to a popular misconception of what such an object should be Folks see a shooting star—a blaze of fire in the sky. They assume from this that the stone itself should be burned to a crisp when it lits the earth As a result the most frequent specimen sent in for identification is a chunk of slag from some furnace.

Actually, if you pick up a stone that seems exceptionally heavy for its size, it is well to make inquiries. Meteorites are about the heaviest of rocks, Some of them are pure iron and nickel. Even in an iron manufacturing district, lumps of pure iron are very rare, and if you find one anywhere else the chances are greatly in favor of its origin in outer space.

Even the so-called "stony meteorites" contain a good deal of iron and are heavy enough, compared with ordinary stones, to arouse suspicion. A good way to get corroborative evidence is to take such a stone to the grind-tone and grind away a small bit of surface. If you find the area thus exposed speckled with iron particles, the chances are rather good that you have a meteorite. Do not injure the exterior surface too much, as it is of interest to the students of meteorites.

The discovery of a meteor is always worth while to the finder, although the value is not

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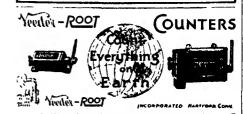
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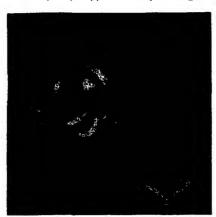
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It is sometimes wondered why a meteorite can strike the earth without setting everything on fire if it lands in combustible material. Strangely enough such an object might not be too warm to hold in the hands It entered the earth's atmosphere far colder than anything on earth could possibly get except in a special laboratory. It made its whole journey to earth in a few seconds Only an extremely thin layer on the outer surface was heated and this heat did not have time to penetrate the interior. So, if you should happen to see one of these balls of fire strike the earth rush to it and see how warm it really is. There is only a slight chance that it will be hot enough to burn your fingers. There is at least an equal chance that the meteorite may be covered with frost

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maccuracies of set-up and conditions of shaft misalignment without binding or in any way impairing the load carrying capacity of the bearing. In addition, the use of this unit brings about manufacturing economies because it requires no machining of the shaft.

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lionths of an inch thick has a straw-yellow color, while a streak nine millionths of an inch thick appears red. The colored areas thus constitute an accurate contour map of the "topography" of the oil film, the scale of contour levels from one color to the next being one or two millionths of an inch.

The colors reflected by transparent films having thicknesses less than five 100,000ths of an inch, called interference colors, have been understood since the days of Isaac Newton. However, until 1934 no method was known of building standard films of known thickness which could be used as color gages for measuring films of unknown thickness.

A method which was devised in the Gen-

A method which was devised in the General Electric Research Laboratory employs sheets of barium stearate which have a unform thickness of one 10,000,000th of an inch. Each sheet consists of a single layer of molecules of barium stearate. The layer is prepared by placing a small amount of stearic acid on water containing a barium salt. The individual molecules of which the stearic acid is composed endeavor to attach themselves to the water surface, with the result that the stearic acid spreads out over the water until each molecule has a place on the surface. The molecular layers are transferred to a metal surface by a dipping process at a rate of about 20 layers per minute.

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MARKING INK FOR GLASS

THE problem of marking on glass or vitreous enameled surfaces has apparently been solved by a new type of marking ink recently perfected. The ink may be ap plied, with a steel or other pen or a marking brush, to the glass surface, preferably warmed, and when dry is resistant to all types of destructive agents, including strong acids and alkalies even when hot, and the common organic solvents. The ink itself is non-corrosive and non-flammable, in which respects it is more convenient than hydrofluoric acid marking fluids and organic substances -- D H K

SOLDERING ALUMINUM

LUMINUM is hard to solder because of A the oxide film that forms on it, according to The Foundry, which states that molten solder will not wet or alloy with aluminum covered with oxide. The most practical method, it says, is to abrade the surface of the aluminum under a film of molten solder so that the solder can wet the freshly exposed surface before it comes in contact with the air. When a small amount of solder has been melted on the surface, the solder is rubbed or worked with a wire brush. This abrades the surface, removes the oxide, and exposes a clean surface.

SIMPLE--WHEN YOU KNOW THE ANSWER

AFTER an amateur has given up finding fossils in a given locality, a professional paleontologist often will go to the same locality, walk directly to a definite spot and unearth fossils, much to the amateur's puzelement. Accordingly, the amateur often asserts that the professional must smell the fossils, for there apparently is no other way by which he could locate them. There is, however; the professional knows many a



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sign that the amateur never notices. And so it is with the archeologist, who seems to know where to look for buried human artifacts when there seemingly are no visible signs or clues. Again, however, it is often 'so simple" when the explanation has been given, For example:

Not only is vegetation more luxuriant over the sites of abandoned human villages in the Far North but it is composed of different varieties, says Dr. Ales Hrdlicka, Smith-sonian Institution Curator of Physical Anthropology, who for 12 years has conducted archeological explorations in Alaska and the Aleutian Islands. Some plants seem not only to follow the footsteps of man but to cling tenaciously to the remains of his settlements and to his graves.

"One of the main results of these explorations," says Dr. Hrdlicka in a recent report to Science, "has been the location of literally hundreds of more or less ancient sites. They cover from approximately one half to more than ten acres. They are kitchen middens and village sites combined, their accumula tions reach in depth from a few feet in some to more than 16 feet in others, and while some are fairly late others show human occupancy of many centuries

The appermost of their deposits reach from historic to pre-historic time. The accumulations consist of ashes, shells, sea urchin spines, rotted wood and sod, bones of fish, birds and various mammals, blown silt, and all the organic refuse and cultural objects of such communities. In their constituents, depth, and other conditions, they are largely different from the soil of the surrounding country

"Owing to these factors, the sites present wide and in some cases seemingly almost absolute botanical differences from the rest of their region. With some experience it is possible to detect such an old village site as far as it can be seen with some clearness. Its vegetation is darker and much richer in development. It sometimes reaches to over four, five, and in some cases six feet in height. At close range, moreover, it is seen to consist materially of different species of plant from those of the neighborhood Some of these plants apparently exist nowhere elsein the region, while not a few of those in the vicinity, in turn, do not grow on the site of the human habitation

"Apparently under different physical and chemical conditions in the ground the same region may produce very different and richer flora than is characteristic of the region under ordinary conditions"

CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific Amer-ican when writing for any of the publications listed below)

HUNTING WITH THE MICROSCOPE, by Gay lord Johnson, is a 96-page book, thoroughly illustrated with line drawings, that "tells all" about the interesting hobby of microscopy. It describes the uses of simple lenses as well as of compound microscopes, and gives instructions for making and using accessory equipment. "What to Look for With the Microscope" and "How to do

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THE OBSERVER'S HANDBOOK contains planetary and lunar data for each month of 1939, also star charts and numerous tables and summaries having practical value to amateur astronomers, very many of whom obtain the booklet each year from The Royal Astronomical Society of Canada, 198 College Street, Toronto, Ontario, Canada, for 25 cents

COLUMBIAN COLLODAL CARBONS is a 194-page book with semi-flexible covers, which deals with the industrial uses of colloidal carbon in the manufacture of rubber, inks and paints, and various other compositions. Attractively illustrated and complete in every respect. Binney & Smith 60, 41 East 42 Street, New York City —\$150

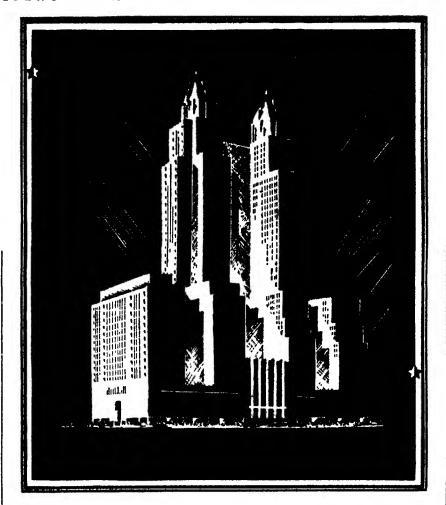
EQUIPMENT CATALOGUE, designed especially for radio "hams," service men, and sound equipment men, comprises 44 pages and has been compiled by an old time "ham" who is as familiar with quality requirements as are the users of the equipment listed. Sears, Roebuck and Co, Chicago, Illinois—Gratis

Modern Enlarging Technique, by Hanns Neumann, is a beautifully illustrated 54-page book that deals with the whole subject of photographic enlarging from "Why negatives are enlarged" straight through to "Mistakes, and how to recognise them" It covers enlargers in general, the darkroom and its equipment, negatives and enlarging papers, exposure, and all steps in the entire process. The numerous illustrations assist in an understanding of the comprehensive text. Burleigh Brooks, Inc., 127 West 42 Street, New York City —60 cents

SAFETY IN STEEL is a 20-page illustrated pamphlet that tells briefly the running story of industrial safety, particularly as applied to workers in steel plants. It deals with such things as protective clothing, safe operation of machinery, avoiding dangerous falls, and so on. American Iron and Steel Institute, 350 Fifth Avenue, New York City.—Gratis.

THE MERCURY SWITCH OF TOMORROW, Bulletin No. 500, is an eight-page pamphlet which describes Durakool Mercury Switches, which are now finding wide application in industry in general. "Few indeed are the switching jobs which cannot be done more safely, more surely, and in the long run more economically" with the switches described in this circular. Durakool, Inc., Elkhart, Indiana.—Gratis.

CREATIVE HANDICRAFTS, by Mabel Reagh Hutchins, is a 94-page hobby instruction book that will point the reader along the path toward making profitable use of spare time. It gives instructive and specific suggestions, accompanied by pertinent illustrations, in the following hobbies: pottery, weaving, basketry, metalcraft, leathercraft, bookbinding, block printing, and dyeing. Leisure League of America, 30 Rockefeller Plaza, New York City.—35 cents.



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TRY CROPPING IT

OOKS are sometimes deceiving. If a nega-A tive seems hopeless at first glance or even after some study, do not throw it into the discard without first giving it a chance to display its possibilities by projection on an easel under the enlarger Such negatives may sometimes be faulty because of poor judgment in taking the picture, unsuspected movement on the part of the subject which threw your carefully laid plan out of line, but which you shot just "on a chance," or other causes. But whatever the reason for doubting the print possibilities of a particular negative, do not trust first impressions Project it and see what can be done. There's always time for the waste basket

Take, for example, the illustrations shown here. Figure 1 shows a print from the full negative. We were making a number of flash shots when the mother suddenly lifted the



Figure 1: From the full negative

child into the air, as you see The camera was on a tripod and there was no time to do anything but shoot, come what may. The action was so spontaneous and graceful that picture appeal seemed inevitable. As it turned out when the negative finally came into being, the mother's head was quite close to the edge of the negative, and the chance of a suitable picture from even a part of the negative seemed hopeless for a while.

However, we put it into the negative holder anyway and, with the aid of the margin bands of the easel, made several attempts to frame portions of the negative. The results were decidedly surprising. The first attempt is shown in Figure 2, in which the vertical composition was tried. This did not appear fully attisfactory because the pose of the subjects gave the impression they were both headed straight out of the picture. Good balance seemed out of the question except by trying to cut down the portion of the negative used in making the picture. The projector hous-



Figure 2: Vertical composition

ing was raised to fill the easel picture space with a more limited portion of the negative.

The horizontal arrangement was the next experiment and the result, as shown in Figure 3, seemed to be an improvement. But we still were partial to the vertical arrangement and raised the enlarger housing still higher to make the finally satisfactory picture shown in Figure 4. In the last it was felt that the body of the woman provided a suitable balance and the inclusion of only part of the hoy's image made the picture a stronger one than would have been the case had the boy's legs been included.

Of course, there is a reasonable limit beyond which one cannot go in taking out a piece of the negative to make a whole print, particularly if the latter is to be 8 by 10 or so. This limitation lies in the grain of the negative; the coarser this is the greater the problem of producing a suitable print. However, this difficulty is less troublesome in the larger negatives than the miniature type. In

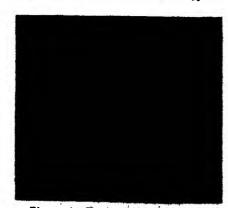


Figure 3; Horizontal companion



Figure 4: The final choice

any event, should a good print be impossible in a larger size, be content with a smaller one. Better a small, good print than a large, bad one.

In the majority of cases, it will be found that a little fussing around with a negative that seems at first glance to be hopeless may prove highly advantageous and result in the saving of a picture that would otherwise have been lost. In short, let the motto be: Crop before you leap—for the waste basket.

COPYING KINK

ERE is an idea from an old-timer that should be helpful when copying faded photographs. Instead of straining the eyes in trying to focus the old, pale image, attach to the copying easel a sharply defined print. When sharp focus is obtained, which should be easy with such a subject, remove the sharp print and substitute the old, faded one. Sharp focus will be assured. This, as you will recall, is based on the same idea as that of scratching a discarded negative and focusing with this when enlarging from a particularly dense negative when the latter, because of the thick silver layer, makes focusing difficult or impossible.

FILM PRICES DOWN

WITH increased consumption of the new high-speed Agfa films, the manufacturers announce they are now able to bring down the price of their films. These reductions apply to Superpan Press film packs, Superpan and Superpan Press film packs, 35-mm Ultra-Speed Pan miniature film, and 35-mm Infra-Red miniature film. All Agfa panchromatic roll films, film packs, and 35-mm miniature films now sell for the same price in each size. Your regular dealer can tell you what the new prices are as they apply to the films you employ.

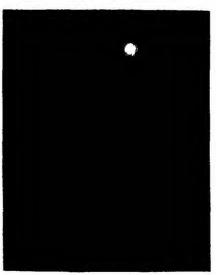
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serve as a protection for the camera user. Such registration cards should always be filled in promptly and immediately sent to the address of the manufacturer or importer given on the card. Should the camera be stolen or lost and you do not remember the serial number of the camera and lens, you have merely to write to the manufacturer or importer and request him to look up your card and give you this vital information. This card also identifies you as a user of the particular photographic equipment, and entitles you to new literature as it is issued. It proves your ownership of the particular camera should the issue ever arise, indicates the length of time the camera has been in your possession, thus assuring you service during the full guarantee period, and is helpful in other ways.

"Moon Over the City"

THE exposure required for making pictures by the light of the moon is 500,000 times that called for when the same scene is illuminated by full sunlight. But that does not make moonlight photography as impossible as it would seem, because no one who photographs a moonlit scene wants it to look as bright as the same scene illuminated by sunlight. Let it look like moonlight The picture reproduced here was exposed for 30 seconds at f/3.5. The outline of the huge



By moonlight

shadow mass and the lighted windows are much more realistic and impressive than would have been the complete details that daylight would have shown.

PHOTOGRAPHY ONE OF THE ARTS

THE works of photographers at their best have come to be regarded on a par with those of artists in other fields, and this opinion is subscribed to by no less an authority than Jonas Lie, president of the National Academy of Design. Addressing the preview of the Pictorial Section of the Annual International Exhibition of the Royal Photographic Society, held recently at the Academy rooms in New York City as a guest of the Academy, Mr. Lie said:

"Let me tell you that we do not feel strange in associating with photographers of this quality. We feel very much akin to the pho-

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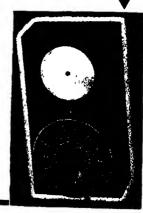
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tographers. They have within their power a great deal of what the artist has. The liberties that the photographer can take are almost as limitless as the liberties which the painter is privileged to take. The advance of photography is stupendous and I think we more and more realize what a great art photography is."

The show was held under the auspices of the Oval Table Society, Inc., of New York, a non-profit organization which in the past several years has been responsible for some of the outstanding photographic shows of the country.

PICTURING THE

JAMBOREE

ONE evening when the weather was somewhat warmer than it probably is at the time you are reading this, we had the interesting experience of attending an outdoor



"The Skeptic"

charity tamboree. A number of tables were set up along the roped off street, each presided over by a lady palmist, sketcher, or person of similar gifts. As we wandered from table to table we sensed the human interest possibilities and shot some candid pictures by the light of the 100 watt lamps suspended over the tables A fiftieth at 1 4 did the trick on supersensitive pan film. One of the shots was the one shown. "The Skeptic."

"BLACK AND WHITE" OF WATER PHOTOGRAPHY

THE water will show a "white" path where the sun is allowed free rein, as in "White Ripples," but will reveal a "black"



"White Ripples"

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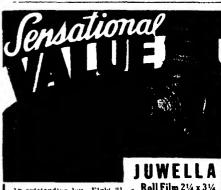
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"Black Ripples"

path where the sun is blocked, as in "Black Ripples" In the latter case, the sun was just back of the boat's mast, in the former, it sent its late afternoon rays clear across the water, since there was nothing to intercept them Of course, "White Ripples" is a demonstration of reflections of the sunlight, and 'Black Ripples" is an example of the absence of these reflections. On the other hand had the sunlight been coming from the other side it would have illuminated the section of the boat shown in the picture and reflections would then have appeared in the water, though naturally much darker in tone than those of the direct sun light Moreover, were the boat lighter in tone. the reflections in the water would have been proportionately brighter

WHAT'S NEW

In Photographic Equipment

Alf you are interested in any of the stems described below, and cannot find them in our advertising columns or at your photo graphic dealer see shall be aliad to tell you where you can not them. Please accompany your request by a stamped envelope.

PHOTAR (\$8.75) Photo-electric exposure meter Large rapid-calculation dials. Announcement stresses sturdy construction yet delicate jeweled mountings of mechanism Licensed under Weston patents, meter conforms to range of speeds prescribed by Weston ratings, with range extended so that the instrument may be used with the new highspeed films.

Electromatic Spied Printer (\$35) Through use of two photo electric cells,

this new fixed focus Model El-A automati

rally controls exposure time for each 35 mm negative in accordance with its density. Direct enlargements to 2% by 414 inches Operates on 110 volt, A.C. or D.C., taking but five seconds to ex-



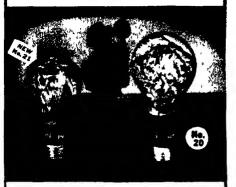
pose print from negative of average density. Printer has four lenses, two optically ground and matched-condenser lenses and two lenses combined to form the achromat objective

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NEW LOWER PRICE ON No. 20 (Has more "peak" light than No. 21) 22

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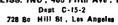
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lens. Surface reflector system gives flat field illumination. Two levers provided, one setting timer for hard, medium, or soft paper; the other permitting choice of paper contrast. Printer cabinet all metal, mounted on rubber feet.

Argus Monet C2 (\$25). Equipped with coupled range finder, huilt-in calibrated split-image sextant type. Lens 50-mm Cintar

f/3.5 anastigmat, equipped with frontoperated iris diaphragm, moves as a whole in helical tube mount, focusing from 3½ feet to infinity. In-



terchangeable mounting permits use of other lenses and attachments, including macro attachment for close-up photography and new copying lens and portrait attachment. Behind-the-lens shutter provides speeds 1/5 to 1/300 second, plus "hulb." Camera trimmed in metal and polished plastic with black morocco leatherette covering. Separate view finder and range finder.

LAFAYETTE FOTOLITE REFLECTORS 10- and 12-inch general purpose reflectors, five-inch "spot" reflector. Made of spun aluminum with parabolic reflecting surfaces corrected to combine maximum light concentration with even light distribution. Rubber-covered spring grips with ball-and-socket joints permit them to be attached anywhere Push-switch sockets of standard size to accommodate No. 1 and No. 2 Photoflood lamps; equipped with 6-foot Underwriters approved cord and plug.

BROWNIE SPECIALS, SIX-20 (\$4), SIX-16 (\$4.50). Made with tapering fronts and curved backs. Camera case and film holder



of steel, outer metal parts finished in smooth black japan, with panels covered in black pin-grain Kodadur. Tubular "spy-glass" type finder mounted on top of camera and used at eye-level. Shutter

release and film-winding knob on top of camera body. Focus pre-set, with sharp focus 10 feet to infinity for the Six-20 and 15 feet and beyond for Six 16. Built-in supplementary lens brought into position by lever allows sharp focus for nearer objects. Safety catch prevents double exposure. Rotary type shutter with time exposure lever. Tripod socket, folding metal foot, folding carrying handle. Fabric carrying cases with shoulder straps and slide fasteners \$1 10 for Six-20; \$1 25 for Six-16 Six-20 takes pictures 2½ by 3½ inches, Six-16, pictures 2½ by 4½ inches.

Lettz VIII-C 100-watt Projector (\$42 without lens): Designed for home use, visual education and for salesmen who desire still film projector for showing pictures before small groups of people. Measures 6½ by 6½ by 3 inches, not including lens. Made of plastic and metal Embodies black top 100-watt, 110-volt projection lamp for projecting either 2 by 2-inch glass slides or 35-mm film strips. Three-lens condenser sys-



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tem and silvered reflector behind projection lamp. Condenser system removable so that either 50-mm Leica camera lenses or Hektor 85-mm //2.5 projection lens may be used. Heat absorption filter between lamp and condenser system. Current controlled by toggle switch built into rear of projector.

MICROGRAIN ENLARGING EASEL Makes use of microscope built into framing easel through which actual grain of emulsion is

seen, focusing is done on film grain instead of on image as usual "When focusing with this new device," announce the manufac-



turers, "the magnifying power of the optical system is so great that the image is not seen at all, but when the grain of the film becomes sharply visible the image of the negative is automatically brought into the most critical focus on the surface of the printing paper," Magnification is 15 times magnification of enlarger. Easel provided with quickadjusting paper stops permitting border to be varied to any width. Rigid metal construction with die-cast framing clamps

"S F." REMOTE CONIROL (\$21.50) Robot camera attachment. Operates on electromagnetic principle and works the camera with aid of small dry cell and 15 feet of special light-weight cable Finished in chrome Can be instantly attached to Robot By simply pressing small button at end of cable, camera shutter is tripped and picture is taken, "Because of the action of the Robot which allows the taking of a series of 21 pictures without rewinding," say the distributors, "the S.F. permits taking almost an entire roll of film without approaching the camera for any adjustments. During the set of exposures, the photographer is not obliged to disclose his presence or efforts to the sub-

MOUNT-O-GRAPH Device for positioning prints on mounts. Centers all sizes of enlargements on all mounts. Resembling T-square, device is simple to use, involving three motions centering picture on mat, lin ing up borders, and determining top and bottom margins

EAE ENLARGER (\$14.75 to \$21.25) 35-mm enlarger featuring new system of illumination (see drawing) employing reflected



light rather than direct diffused light Manufac turers claim coolness of operation, greater protection of negatives, flat-field illumination. Enlarger designed for use with Mod els A and AF Argus cam-

eras or with special enlarging lens and adapter mount, Argus adapter lens (/ 56 triple anastigmat) has aperture slide with 1 8 and 1 16 openings Film holder is Bakelite molded, book-type, without glass. Handles either single negatives or strip film. Illumination by 100-watt pre-focused projection lamp, which is placed at right angles to the optical system Thus only the center portion of the lamp, where flattest and most even illumination is available, is picked out and reflected down through condensers.

Bass Bargaingram

VOL 29 179 WEST MADISON STREET, CHICAGO, ILL. NO 2

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KALAR TO PHOTOGRAPHIC DEVICES



JACOB DESCHIN, conductor of our "Camera Angles" department, will answer in these columns questions of general interest to amateur photographers. If an answer is desired by mail, enclose a stamped, addressed envelope Queries should be specific, but Mr. Deschin cannot undertake to draw comparisons between manufactured products nor to advise on the purchase of equipment or materials.—The Editor

Q. In one of the requests in the Camera Angles Round Table there was reference to "circle of confusion." Is there any definite way of finding this circle of confusion? I would like to know the circle of confusion of the x x f 3.5, 75-mm lens on my camera. Can you help me?—T. S. B.

4 The 'circle of confusion' designated in calculating a depth of focus table for a particular lens is not a fixed, but is a variable factor, as explained in our reply to P. P. A in the September, 1938, issue, depending chiefly on whether the resulting negatives are to be enlarged and to what extent. In your case, allowing for enlargements usual with negatives of this size, a circle of confusion of 1.500 of an inch is regarded as appropriate However, a larger disk would be permissible if only small enlargements are to be made.

Q. I have recently heard of a new method of printing contrasty negatives called "Tone Separation." The exact details are not known to me. Can you describe it?—F. E. L.

A This was explained by P. S. Milne in an article which appeared in the January 26, 1938, issue of the English photographic magazine, "The Amateur Photographer and Cinematographer."

O Can you suggest a formula for making an ink with which to write on negatives or prints?—L. R.

4 Such an ink may be made up according to the formula given. When used on negatives or positives there is a bleaching action which leaves the writing white.

Potassium iodide 2 ounces Iodine 90 grains Gum arabic 90 grains Water 6 ounces

Q. I would appreciate it very much if you could describe for me the elementary equipment and procedure required properly to develop a roll of film.—E. I.,

A Paring available equipment to the barest essentials and having in mind that you prefer the least possible fuss, you will pur chase a "daylight" developing tank; a bottle of liquid developer that may or may not require dilution, as you prefer, or a tube of developer chemicals for solution in an indicated quantity of water, a bottle of concentrated liquid fixing solution or the necessary dry chemicals conveniently available in halfpound or pound packages ready for dissolving in water, a graduate, a stirring rod their mometer, and film clips for hanging your negative strip up to dry

The recommendation of a tank may seem an unwarranted expense, but for the man with limited or no facilities the advantage is obvious, it obviates the use of a darkroom. The only time absolute darkness is required is when the film is being loaded into the tank and this step may be accomplished very simply by suffering a few moments of discoin fort behind a heavy barricade of hanging clothes in a closet corner. With the film loaded and the tank firmly closed, the rest of the business may be done in full daylight or electric light.

Prepare the developer as indicated on the bottle or package which you purchase, using the staring rod thermometer to sur up the solution and to be sure that the temperature of the solution is that required Pour the developer through the hole in the develop ing tank Leave it there for the required time During the interval get your rinsing water and your fixing solution ready, both at approximately the same temperature as that of the developer solution. When the developing period is ended, pour out the developer and pour in the rinsing water. Swish the water around in the tank for a few seconds. Pour out the rinser and pour in the fixing solution. Allow a fixing period of 10 to 15 minutes and pour out the fixer. Then wash for a half hour or so, allowing the water from the faucet to run directly into the tank. At the end of the washing period, at tach a clip to each end of the roll, swab off the surplus water with cotton, and hang the film up to dry. And that's all there is to it.

O. I recently purchased a copy of your book, "New Ways in Photography," and became very much interested in the chapter on transparencies and their application as lamp-shades, and so on. As a result I am now considering a small business along this line—photographing customers and enlarging upon transparency material, mounting upon a shade, and selling them to the individual customer. First, would I encounter any difficulty with

copyright or patent laws? Second, please specify the required transparency materials. Third, what toners are available for transparencies?—D. W.

A. As to the first question, the making of transparency lampshades has been done for a long while by various methods and many persons. The principle of making lampshades by this method is not patented and is free to be employed by anyone. Second, Eastman Translite materials and Defender Adlux are both eminently suitable for the purpose. Both Translite and Adlux are double-coated, that is, the emulsion is coated on both sides of the paper or film, whichever the case may be. This aids in providing the transparency image with plasticity and roundness. Both materials are available in several standard sizes. Third, since the emulsions are no different from those normally employed on regular printing paper, any of the standard toners suitable for regular papers will do as well for Translite and Adlux.

Q. I wish to use the xx camera for taking pictures of the human eye and would like to have an additional lens tube that would give a normal size image; that is, 1 to 1. How long a tube would be necessary, how far would this place the lens from the eye, and what would be the added time of exposure?—Dr. A. G. S.

A A "normal" or life size image of a subject is obtained at an extension which don bles the focal length of the camera lens That is, with your 2 mch lens, a tube would be necessary that would extend the focal length of the lens to four inches. This same distance should intervene between the leas and the subject so that the total distance, from the plane of the film upon which the exposure is to be made to the focused plane of the subject, is eight inches. The doubling of the focal length of the lens will call for a quadrupling of the exposure time. That is, if the exposure calls for one second exposure with a normal set up, the circumstances will require an exposure of four

Q. Will you please tell me how you dry your 35-mm film? When my film is dry, the sprocket holes are almost touching. I have tried resoaking and re-drying, but to no avail.—L. R.

A Drying 35-min films requires no special procedure other than that the film strip be freed of excess moisture by passing gently between a "sandwich" of cotton or viscose sponges and then hung up to dry in a dust-free place. You know, of course, that the film has a tendency to curl as it is drying but then flattens out again when drying is completed. Too warm a room temperature or too long a drying time might increase this curling. Dry the film within a half hour or an hour and take it down immediately drying is completed. However, forcing the drying procedure through the agency of heat is not good practice.

Q. When using extension tubes with my miniature camers for obtaining large close-ups of small objects, will you tell me if it is necessary to increase exposure time and how much?—H. K.

A. The use of an extension tube for obtaining actual size or one-to-one images of a given subject will call for a total extension of the lens to twice its normal distance from the focal or film plane. As a consequence, the f value of the lens will be twice that indicated on the diaphragm ring. For example, if you have a three-inch lens extended six inches from film plane to center of lens, the f/8 value, for instance, will really be f/16 and must be so considered. This will mean an exposure four times that required for the f/8 opening were the normal extension employed. Similarly, with an extension of 4½ inches, the f/8 value will be f/11 and call for an exposure twice normal.

Q. Could you tell me the names of manuals, pamphlets, books, etc., which would give me information on both ordinary and time-lapse photomicrography and macrophotography with an x x 16-mm movie camera?—W. T. H.

A A most practical book on this subject, which is also a story of personal achievement in this field, is "Picturing Miracles of Plant and Animal Life," by Arthur C. Pillsbury A treatise on this subject is contained on pages 323 to 338 of a Smithsonian Report, 1937, by W. N. Kazleff, the title of which is 'Moving Photomicrography "Other works on photomicrography include "Photomicrography An Introduction to Photography with the Microscope," "Practical Photomicrography," by J. E. Barnard and F. V. Welch, and "The Student's Manual of Microscopic Technique," with instructions for photomicrography, by J. Catroll Tobias

Q. Can you tell me how practical is the use of a Photoflood bulb for cularging purposes?—S. G. N.

4 Completely so, and particularly serviceable when employing the diffuser type of illumination and when a fairly dense negative may take a long time to print, especially where blown up considerably. When controlled by a rheostat device, the Photoflood bulb may be burned at "low" for focusing purposes and then burned at "ligh" for the actual exposure. A housing well designed as to ventilation is important when employing Photofloods Those who disfavor Photofloods in columners complain, among other things, that the light intensity does not remain constant throughout the life of the bulb, that this intensity is considerably lowered toward the end, that the total lefe of the bulb is only 112 hours when used this way and that the bulb has a had habit of suddenly burning out in the middle of an exposure. However, take the one with the other and decide for yourself. There is something to be said for either side.

Q. What is the best type of material to use in making a photographic light reflector for use as an auxiliary lighting unit?—L. D. K.

A Any white surface will do the work, of course—a newspaper page, a white sheet, and so on However, the most popular home made reflector is an ordinary cardboard covered with sheets of the foil in which films and papers come wrapped, Matt foil is said to give the best diffusion, while others prefer the regular photographic white blotters. Aluminum foil, however, is said to afford better tonal values than the white blotter reflector. When using odds and ends of pieces of this foil in making a reflector it is important to glue them down to the cardboard as flat as possible, flattening them out under a print roller.

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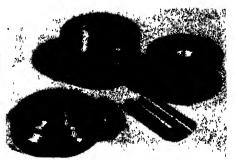
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TELESCOPTICS

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IN measuring a room we lay the measure directly on the floor, and we do the same in measuring somewhat finer work, but when it comes to measuring the separation



Figure 1: Coordinate comparator

of two star images on a plate this method is not followed by the astronomer: too rough. Instead, he mounts a microscope above the plate, makes provision to move it accurately in two dimensions of space, setting it first above the image of a selected "standard" star and then above that of the star to be measured, and reads off the difference on an accurate scale. At no time does the measure actually touch the plate, and the microscope permits centering by judgment on as indefinite an area as a star image It magnifies 5X to 35X.

Figure 1 shows a typical measuring engine of this kind, a "coordinate comparator" made by Gaertner for professional astronomers' usc.

First, the carriage as a whole is slid up or down the sub-base, to place the microscope in a comfortable position for the user. On this carriage is mounted the circular stage, showing clearly in the figure. Within it lint obscured by other parts, is the plate, set in a square recess. This stage, its periphery di vided into angles, may be rotated by means of the little hand crank shown, and it is rotated until the two star images successively fall under the sliding microscope. The scales are read at each setting and then the angles and position are determined from the readings. The microscope is mounted on a slide and runs on a long, precise screw beneath the slide, a screw having in this instance a periodic error of less than 0 001 mm, or about 1'25,000 inch On the left end of this screw is a drum with a scale and this gives direct readings to 0 001 min. The microscope reticule consists of two hairs set parallel and one at right angles to these Angular separation of the stars may be calculated because the scale of the plate is known or may be computed However, such an apparatus, costing as much

as a fine car, is out of the amateur's reach.

The plate measuring engine shown in Figure 2 was therefore made by Lawrence A Cox, one of the Cox brothers living at 47 Upper Green, Mitcham, Surrey, England, whose telescopes and observatory have previously been described here, and is described by Harold W. Cox They have omitted the circular stage, and they measure by means of a two-stage carriage arrangement, obtaining rectangular coordinates, probably working out the hypothenuse by trigonometry. "Basically," Cox writes, "the instrument

"Basically," Cox writes, "the instrument consists of a frame or plate holder I, to hold the negative or plate, which can be moved accurately in one direction along round rails 2, 3, by means of the fine adjustment provided by micrometer screw 4. These rails are made from lengths of ½" silver steel rod purchased in very straight lengths. Motion at right angles to this is made possible by allowing the microscope 5 to slide on round rail 6 and flat rail 7; it can be moved more accurately by means of micrometer screw 8. The microscope not alone travels on round rod 6 but is hinged on it also, and may fur-

6 10 14

Figure 2: The Cox apparatus

thermore be swung back out of the way when required thus.

"The micrometer screws 4 and 8, of which 9 and 10 are the extensions, are ordinary heads from L. S. Starrett metric type machine micrometers and permit an adjustment range of 1/2", actually, only 1/2" cm of movement is used. Extension 9 is kept forced against 4 by a spring thrust, 10 against 8 by gravity. When measurements are made between star images more than 1/2 cm apart. we make use of a glass reference plate or reticule 11, ruled with fine lines, which divides it up into sections 1/2 cm square. The plate is a photographic copy of a master ruled plate at Greenwich. Both the microscope and the plate holder can be released from the threaded micrometer extension, moved in position to bring star and microscope coincident, and then locked in position by milled-head clampscrews 12, 13. Position is then read by counting off the lines on the reference plate or reticule and interpolating the rest by adjustment of the micrometers.

The use of the reticule serves to reduce errors which would be cumulative if a long micrometer thread were used instead of the ½ cm movement, also errors caused by curvatures in the rails that carry the moving parts.

"Finally, the microscope itself has a crossreference, in the form of very fine scratches on glass on a piece of microscope slide cover, made with the sharp edge of a piece of broken quartz rod. Even after several such scratches have been made with the same edge the scratches obtained are finer than those obtainable by most other hand methods. Cross-wires would be much too coarse, as this apparatus has a direct reading accuracy of 0.0001" (inch) on the micrometer scales and, by interpolation, to 0.00001".

"The reticule is always in position and the photograph for inspection is laid on top. The two are illuminated from below by a lamp in a white enameled base. Looking through the eyepiece of the microscope one can see the cross lines in the microscope, the star images, and the lines of the reticule, all in focus at the same time. Sometimes the cross-

lines in the microscope are removed and a fine metric scale engraved on glass is used instead. The lamp in the box 14 is so arranged that direct light does not illuminate the plate, but reflected light from the white walls gives an even illumination over the whole plate. As shown in the photo, the plate holder takes but plate size, but with an extra fitting dropped into position any smaller plate can be measured.

"Owing to the fact that any other person making a plate measuring machine would have his own ideas about details I don't think it is worthwhile including them here."

Regarding this, we agree with Cox and the author of page 84: few wish to copy details slavishly.



Figure 3: The Cox No. 1 Schmidt

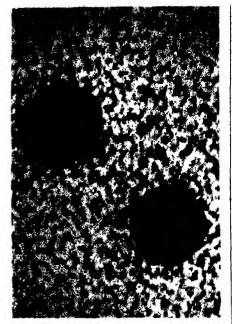


Figure 4: Your scribe's pet sun-spot

SCHMIDT camera (Figure 3) having a 9" mirror and 61/2" correcting plate (hence f'1.5) has also been made by the Coxes, and stellar photographs taken with it and submitted to Lower, of San Diego, California, for opinion elicited the significant response, "the Coxes have made a Schmidt " The images were remarkably fine and round.

Now follows the sad tale of a self inflicted



Figure 5: The Cox No. 2 Schmidt

joke on this department. A little later the two Coxes sent the photograph shown in Figure 4. On the same day came Professor Russell's manuscript for his September article entitled "How Hot is the Sun?" Calculation showed that something was needed to make it fit the usual two-page space-what better filler than this Cox picture? Study closely the familiar solar rice grain background and all its other details. The picture was inserted and given the legend, "Sunspots photographed with a 12" reflector, by L. and H. Cox." The present reproduction is from the same half-tone plate that was shown in September.

Well, as it turned out, the "sunspots" weren't quite that—not precisely. Instead, they were a 140 times enlargement of two star images at the edge of a 16° field taken with the Schmidt camera shown in Figure 3' The photograph had been sent to demonstrate the quality of the Schmidt. Note particularly the absence of coma in the round, clean-cut star images. However, there were

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THE BEGINNER'S CORNER

BUGBEARS of the tyro's first telescope include the mounting for the diagonal. From S. R. B. Cooke, Assistant Professor of Metallurgy at the Missouri School of Mines and Metallurgy, Rollo, Mo., and an amateur astronomer, we have received the following:

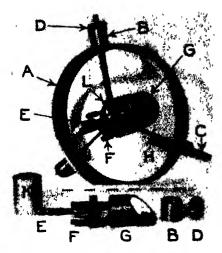
"Seldom have I seen in your columns a description of a satisfactory, easily made, yet rigid, secondary mirror support. I send a photograph of a type of support which I have used for 15 years in reflectors from 6" to 20" aperture. During that time I have found it to be the essence of rigidity, possessing the added ment of rapid adjustability. I do not claim originality of design, in fact the first telescopes in which I saw it used were those manufactured by Mr. J. T. Ward, of Wanganin, New Zealand. I strongly believe that a similar support was used by Browning, of London.

"My first reflector was a six inch, made in 1923 according to the articles by Ellison in English Mechanics. The flat support was made of the criidest materials, by the use of simple tools such as hacksaw, file, and a kit of bicycle tools, and it performed perfectly.

"The photograph shows at the top a complete assembly for a 121/4" Cassegrain, and, below, a flat mount from a 101/2" Newtonian, the last-mentioned instrument having been made for selenographical work Istudy and mapping of lunar detail -Ed | A is a strong steel ring, which fits just outside or within the tube proper At positions 120° apart on the steel ring, three bolts, (, pass through square holes cut in the ring. The fit is easy These bolts are riveted to flat strips of spring steel, H, which form the spider. A sleeve, B, fits over the square portion (shown near () of each bolt, and tension on the spider system is maintained by the knurled nuts D The support for the mirror mount is a threearmed steel spider, L, each arm being slotted and firmly bolted to a spring steel spider arm.

"G is a brass tube holding the nurror. It is firmly attached to a circular steel plate by means of the three adjusting screws F. A helical steel spring fits over each adjusting screw and, for rigidity, is maintained at considerable compression. These springs are shown in the flat mount in the lower portion of the photograph.

"The mirror mount is attached to the spider by means of the elongated nut E. This acrews on to a bolt attached to the circular steel plate, and which passes through a hole bored or drilled in the heavy steel spider. E is long, to facilitate attachment in the relative gloom of the interior of the tube.



A secondary-support assembly

"The secondary mirror is adjusted centrally by the knurled nuts D. Collimation is effected by the adjusting screws F

"K is a light-weight metal cover which slips over the brass mirror mount when the telescope is placed away for the night.

"Professor W. H. Pickering stated that the New England climate was the world's worst, as far as observing was concerned. It could not possibly be worse than the Ozark climate, in this respect. After ten years of it I find myself longing for the steady New Zealand atmosphere."

When a prism is used for a diagonal the mount will of course be modified accordingly Few types will need so fine a mount

TELESCOPTICS

(Continued from preceding page)

signs of coma elsewhere for your scribe went straight into a coma, especially when it turned out that the photo had been correctly described in the original Cox letter Hereafter, this department is wearing two pairs of specs.

Several months have elapsed since the misnamed photograph was published. No reader has written the editor to apprise him of the error. No doubt all you readers noticed it, of course! For kindly forbearing to write in about it all are thanked. Their innate tenderheartedness has been quite touching.

So your scribe's face is red, red, red, almost infra-red, and now at sight of a sunspot picture he simply breaks down and sobs.

ORE recently the Coxes have sent Figure 5, showing their No. 2 Schmidt job, an f/1.5 with a 12" f/0.75 primary and a 612" correcting plate. It covers a full 20° field. The cell for the correcting plate is all metal and alone weighs 120 pounds. Two

doors, similar to those in Figure 3, show slightly on top of the tube; these bed down on rubber seatings.

To the Journal of the British Astronomical Association, Vol. 48, No. 8, the Coxes have contributed a 5-page article describing their work in figuring the correcting plate and making the film holder. Too long to reprint here, your scribe will lend it for a brief time to any who seriously aspire to make Schmidts.

POURTH Cox item is a chronograph (Figure 6) "for use in our observatory," as they describe it. "We experimented with various forms of recording, one of them being that of burning holes in the paper by an electric spark. The voltage of the ordinary house supply was stepped up by a transformer, about 700 volts proving best for the paper we were using, and one side of the output was connected to a platinum point fixed to the armature of the magnets and the other side to the metal track over which the paper runs. The impulse from our clock, a Synchronome having an accuracy of about one second per month, actuated the magnets,

bringing the platinum point into contact with the paper, which was not sufficient to act as an insulation from the metal track.

"However," they continue, "this method was abandoned, as the sparks made interference with the radio used for giving clock checks against Greenwich. (We did this by connecting the radio receiver in place of the personal switch and then comparing recordings of our clock against that of Greenwich, and by this method we can check to an accuracy of about 0.1 second every day.) We are



Figure 6: The Cox chronograph

now recording with the two siphons shown in the photograph, fed from a small tank of ink fixed to the inside of the track. One of these is fed from the seconds contact on the clock and the other from the half minute impulses and also from the personal switch"

PRINCIPLE of a simple micrometer for measuring angular diameters, also for relative measurements of detail on Jupiter and other planets, is shown in Figure 7, redrawn from a sketch by F L Frazinc, 1016 17th Ave. N., St. Petersburg, Fla. Adapter tube for connection to telescope. Brass plate soldered to this. To that, in turn, is soldered

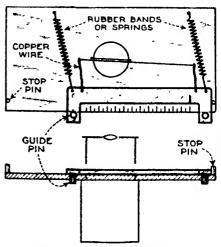


Figure 7: Frazine's micrometer

a bracket to support eyepiece, the eyepiece alone being sketched in on the drawing. Rider on plate.

Lap one edge of plate straight Drill %" hole in center Cement silk fiber or spider web across hole and at small angle with straight edge of plate Second fiber is cemented to copper wires shown, and adjusted parallel and precisely over the first by bending these wires. At same time rider is at right-hand stop. "As I have constructed it." Frazine says, "the full scale reading equals 50 seconds and the scale is in 25 divisions. I find the micrometer is accurate to about 1 second of arc. To calibrate it, I timed a star from web to web when the webs were set wide apart."

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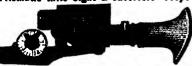
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THE experimental, in contradistinction to the theoretical, physicist must be thoroughly at home in the laboratory, devising and inventing, constructing a wide variety of apparatus, and capable of doing refined mechanical work in many trades and skills. Laymen frequently inquire for treatises on these skills, only to learn that many of them have never been exposed in written form; one scientist learns direct from another-if he happens to be near that other. Now, in this unusual book, Dr Strong. the well-known pioneer of the process of aluminizing mirrors by evaporation, assisted by four other scientists who have mechanical leanings, has assembled a wealth of useful data of a wholly practical kind for the constructor, experimenter, and skilled craftsman. In 15 chapters the following are covered, laboratory glass blowing, optical work; high vacuum technique, evaporation and sputtering; using fused silica, electronieters and electroscopes, Geiger counters, vacuum thermopiles, light sources, filters, and optical instruments, photo-electric cells and amplifiers, photography in the labora tory; heat and high temperatures, materials of research, construction and design of instruments and apparatus; molding and casting The many clear, lucid illustrations. drawn by a man who comprehends the work himself, reveal fully as much as the text Advanced amateur telescope makers will discover that the chapter on optical work presents in detail the methods of D. O. Hendrix, head optician at the Mt Wilson shops-the first time a professional optician has made his methods public. The valuable illustrations of this chapter were drawn by Roger Hayward, an amateur telescope maker and architect (642 pages, 6 by 9 inches, numerous illustrations.) -\$5.10, postpaid .-- A G I

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LEGAL HIGH-LIGHTS

Patent, Trade Mark, and Related Legal Proceedings That May Have a Direct Effect on Your Business

By ORSON D. MUNN, Litt.B., LL.B., Sc.D.

New York Bar Editor, Scientific American

TRADE MARK-LAND MARK

IN a decision of monumental importance in trade-mark law the Supreme Court of the United States upheld the exclusive right of the plaintiff to use the trade mark NU-ENAMEL on enamel paint products and sustained the validity of the registration of the trade mark under the Federal Trade

Mark Act of 1920.

Under the common law, descriptive words were not regarded as valid trade marks hecause it was believed that to confer upon anyone the exclusive right to use such words in connection with a product would unduly restrain competitors in the description and designation of their products. Slowly but surely, however, the doctrine of secondary meaning has developed. Under this doctrine where, through prolonged exclusive and extensive use of a trade mark, a descriptive name has acquired a secondary meaning indicating the source or origin of the merchandise to which it is applied, the name will be protected as a valid trade mark. The Federal Trade Mark Act of 1905 which provides for the registration of trade marks does not recognize the doctrine of secondary meaning and descriptive words cannot be registered as trade marks under this act. This led to certain practical difficulties, one of the most serious of which was that American concerns engaged in international business were unable to register their trade marks in foreign countries unless they were first registered in the United States and consequently owners of descriptive trade marks, being unable to register them in the United States, could not register them abroad. To meet this situation a trade-mark act was passed in 1920 which permitted the registration of descriptive

There is a very important distinction between the Trade Mark Acts of 1905 and 1920. A registration under the Trade Mark Act of 1905 is prima facie evidence of ownership by the registrant. This is not true of a 1920 registration. Prior to the present case there has been a great deal of uncertainty as to the nature and scope of the Trade Mark Act of 1920. In the present case the Supreme Court held that under the Trade Mark Act of 1920 a descriptive word may be registered as a trade mark. The Court also held that a registration under the 1920 Act gave the registrant the right to sue in the Federal Courts and to recover treble damages should the defendant be found to infringe the trade mark. The principal distinction between registrations under the 1905 and 1920 Acts, according to the Supreme Court, is to be found in the fact that since the 1920 registration does not carry with it any prima facie

evidence of ownership it is necessary for the registrant to prove in court that he is the owner of a trade mark regretered under the latter act.

In the present case the Court found that while the words NU-ENAMEL were descriptive they had been so widely used and extensively advertised by the plaintiff that they had acquired a secondary meaning indicating that the enamel product so labeled originated with the plaintiff. Under these circumstances the Court held that the trade mark was valid and was the exclusive property of the plaintiff. The importance of this decision resides in the fact that the Supreme Court has recognized the following principles:

1) A descriptive trade mark may be registered under the Federal Trade Mark Act of 1920. 2) A descriptive name or word may become a valid trade mark if it acquires a secondary meaning. 3) The owner of a 1920 Federal Trade Mark Registration is entitled to bring suit in the Federal Courts for treble damages against an infringer.

MUFFLED

N individual is sometimes restrained from manufacturing and selling an article which the rest of the public has a perfect right to make, use, or sell This situation arises where the individual acquired information regarding the article by unfair or fraudulent means.

This principle is illustrated by a recent case in New York in which a manufacturer of silk scarfs or mufflers sought to restrain a competitor from manufacturing a similar scarf or muffler. Plaintiff had conceived of the idea of printing on a scarf, in which the pattern depicted football and other collegiate scenes, a pennant with the authentic color, seal, and name of a particular school or college To reduce the expense of manufacture the plaintiff had his printer prepare a master screen for printing all of the scarf with the exception of the pennant. The master screen was formed so as to accommodate a small insert screen which would print the pennant on the scarl. In this way the same master screen could be used with different insert screens so as to print scarfs having the pennants of the many different colleges. The Court found that the printing of scarfs in this fashion was an original creation and that certain former employees of the printer who prepared the screens for the plaintiff and who had acquired knowledge as to the manner of printing the scarfs while employed by the printer subsequently, for a consideration, made for the defendants a copy of the distinctive screen employed by the plaintiff. The Court also found that the defendants knew

that the former employees had acquired the information when employed to make scarfs for the plaintiff and that they were fraudulently abusing the trust which had been imposed in them when they imparted this information to the defendant. Even though the scarfs had been published the Court held that it would restrain the defendants from manufacturing, exhibiting, and selling scarfs of this type because they had acquired the information by unfair means.

In this connection the Court stated:

"Defendants had a legal right to copy and to sell as their own creation the exclusive model designed by the plaintiff if the model or an inspection was procured by fair means, but defendants had no right to obtain the plaintiff's trade by unfair means."

PAJAMA CRISIS

F by chance any of our readers are of such a temperament that to enjoy a good night's sleep they require individual and distinctive pajamas, we recommend that they patent their pajamas.

In a recent case for unfair competition involving pajamas the Court held that in the absence of patent protection anyone is at perfect liberty to copy the pajamas made by another. In the case in question, the plaintiff manufactured a man-tailored type of pajamas for women, having witty statements and slogans imprinted on the garment. The plaintiff contended that the defendant had copied its pajamas and asked for an injunction to restrain further copying.

The Court refused to grant an injunction, stating.

"Since plaintiff has placed the pajamas upon the market without securing the protection of the Patent Laws, it thereby published the design of the pajamas and no longer has any exclusive property right * * In the absence of a showing of any unfair competition, such as an attempt by the defendant to mislead or deceive the public or to 'palm off' its product as the plaintiff's, equity will not aid plaintiff by restraining another from copying and selling the article in question "

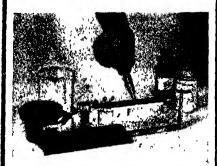
WHAT IS A BOOK?

TE have heretofore pointed out on this page that dictionary definitions and popular interpretations of the meaning of words are sometimes disregarded by the copyright law. An example of this is the rather liberal interpretation given to the word "book."

A recent suit for copyright infringement involved a copyrighted chart to be used in analyzing handwriting. The chart consisted of a single sheet of paper divided into small rectangular subdivisions, each subdivision containing an illustrative specimen of handwriting and a description of the supposed characteristics of a person having that type of handwriting. The Trial Court held that the chart was not proper subject matter for copyright and dismissed the suit. The Circuit Court of Appeals, however, disagreed with the Trial Court and sustained the copyright. In reaching its decision the Court of Appeals pointed out that under the rules of the copyright office the chart was a book and that a book was proper subject matter for copyright.

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CONTRIBUTING EDITORS

A E. BUCHANAN J: Director of Research, Remington Arms Company
L WARRINGTON CHUBB Director of Research Laboratories, Westinghouse Electric and Manufacturing Company
JACOB DESCHIN, Amateur Photography

CHURCHILL EISENHART, Department of Mathematics, University of Wisconsin Statistician, Wisconsin Agricultural Station

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WILLIAM K GREGORY, Professor of Verte brate Paleontology, Columbia University

LEON A HAUSMAN, Professor of Zoology, New Jersey College for Women

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IRVING LANGMUIR, Associate Director, Research Laboratory of the General Electric Company, Schenectady

Director of Research, any
B Director of Research carbonatory, Incandescent Lamp Dept of General Electric Company, Nels Park, Cleveland
D T MacDOUGAL, Associate in Plant Biology, Carnegle Institution of Washington.

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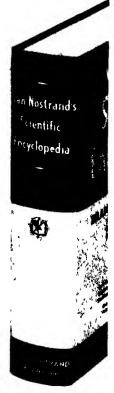
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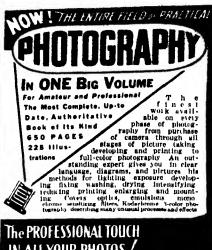
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FRONT VIEW



tree Irial SUNSHINE AT A BARGAIN

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INEXPENSIVE-EFFICIENT The Sun Lamp That Tans Quickly

The new, inexpensive, Home Model, Palm Beach Mercury-Arc COLD Ultra-Violet Ray Sun Lamps give you your own private solarium in which to TAN and keep healthy These

lamps are designed to meet the fast growing demand for low priced home units that are dependable and economical They have all the beneficial qualities usually found

in higher priced Mercury-Arc models
Daily exposure of only 3 to 4 minutes per day will help to improve your appearance and health Will give you that HEALTHY TAN that everyone admires make you independent of weather conditions or season of the year You get vital Ultra-Violet Rays at the mere turn of the switch

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The special type Palm Beach burner is highly efficient and more than 90% of the energy emissions are in the middle Ultra-Violet Ray region, affording a source of almost pure Ultra-Violet Ray radiation

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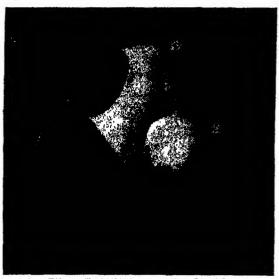
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NINETY-FIFTH YEAR

ORSON D. MUNN, Editor

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W ALKING barefoot on a broad bed of red-hot embers, as shown on the front cover, is a feat performed by Hindoo fire-priests, to the exaltation and emotional frenzy of the natives. Supposedly supernatural, the performance has now been studied by scientists, and a detailed report of their findings appears in the lead article of the present number (page 135). It turns out that there is no magic trick and no deception to the feat, which is honestly performed.

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50 Years Ago in . . .



(Condensed From Issues of March, 1889)

DIPHTHERIA—"It is claimed that 'two professors connected with the Pasteur Institute have discovered the generative microbe of diphtheria, and that a preventive of this disease by means of vaccine virus is expected to follow. Should this expectation be realized, the discovery and its successful application will certainly take rank among the most important triumphs in the realm of medical science."

LINOTYPE.—"The accompanying illustration represents the latest, and in many respects the most remarkable, of the numerous ma-

thines which inventors and mechanics have from time to time devised in their long-continued efforts to find some practical means hy which to supersede or out short the tedious work of typesetting. It is known as the Linotype machine, from the nature of its prodnet . . . It is not, strictly speaking, a typesetting machine, but forms type bars, each of the length, width, and height of a line of type, and the exact counterpart of that which a compositor would set up, except that each line is formed of one entire piece of metal, instead of as many different pieces as there are characters, spaces, etc. . . . The key-board in front of which the operator sits has 107 keys, each marked for a

capital or lower case character of a font of type, or the figures, points, or compound letters used in connection therewith, many of the letters most frequently used having several keys."

MEXICAN RAILROAD—"The engineers of the Mexican Southern Railway have laid out the lines as far as Tecomavaco, 58¼ miles south of Tehuacan.... The new line will carry the American and Mexican railway systems some 300 miles farther south, and will shorten the time from Europe and New York to South American and Pacific ports from a week to ten days in the former, and four to five days in the latter case."

BIG GUNS—"Two monster Russian guns were sent recently to Sebastopol... for the purpose of being placed in the new ironclad Sinope, and although some of the details must be inaccurate, the official description is too interesting to be ignored. They are 12-inch pieces, weighing 50 tons, and throwing projectiles of nearly half a ton. The powder charge is 270 pounds, and the initial velocity 3000 meters [sic], while the distance of the cannons' ranges is said to be 20 versts, or over 13 miles."

MAGNET—"The direct use of electricity as a labor-saving machine has been applied at the great steel works, Cleveland, Ohio, where a large electro-magnet is used, suspended from a crane, to pick up steel bare and billets. It will pick up 800 lb. billets and drop them where wanted, by the touch of a key, the movement of the crane being done by ateam."

SMOKE—"The weight of the great amoke cloud daily hanging over the city of London, England, has been computed by Prof. Roberts

The Control of the Co

at 50 tons of solid carbon and 250 tons of hydrocarbon and carbonic oxide geses for each day of the year, and its value at \$10,000,600 per annum."

INVENTION—"Nine-tenths of the material prosperity of this American Union is due to inventors and their patents. A volume would not suffice to relate the many obligations we owe to the men whose patient investigation and ingenuity have cheapened processes and lessened labor for this prosperous people. Rather let us remove our

hats before the man who has devised a machine by which we may get bread with less sweat."

LIGHT—"So far as we know, every city in the United States is now provided with arc and incandescent illumination, and the introduction of electric lighting is rapidly extending to the smaller towns. Already hundreds of villages of only a few thousand inhabitants have their electric light plants."

FUEL—"It has been demonstrated in Vaca Valley that peach stones will make as good a fire for household purposes as the best kind of coal in the market.... The fruit growers, instead of as heretofore throwing the pits away, dispose of the stones at the present time at the rate of \$6 a ton. A sack of the stones will weigh about 80 pounds and will last as long as an equal number of pounds of coal, and give a greater intensity of heat"

TELEPHONE—"The Metropolitan Telephone Company, of New York, have recently erected a new central station building in

Cortlandt Street, which is of special interest as embodying the latest improvements in telephone central station work and accessories, as well as containing the largest switchboard in the world. At present about 2500 subscribers use it, but all the connections are prepared for 6000, and the board can be extended so as to include 10,000. The building is fireproof throughout."

EIFFEL—"The question of the possible use of the Eiffel Tower for scientific purposes has been often raised, and as yet we have seen no authoritative document on that head signed by any scientific man or indorsed by any learned society, but scientific utility is possibly a secondary object in its construction. The tower will be such a curiosity in itself as to powerfully help to draw many visitors to Paris during the exhibition."



AND NOW FOR THE FUTURE

(Television: What the public may expect when this form of entertainment enters the home.

(How the pure science researcher ferrets out the secrets of the elements.

(Insecticides and how their wide-spread use affects your own personal welfare.

(How oil transportation economies keep gasoline prices down to a low level.

OUR POINT OF VIEW

The Picture Falls Together

FOURTEEN years ago the anthropologist and anatomist, Sir Arthur Keith, ablest authority among scientists on the skeletal remains of ancient man, concluded his notable work on "The Antiquity of Man" with a significant reference to the genealogical tree of human evolution as that tree was then known. "We may hope," he wrote, "to find many more branches." He sensed fully that the five humanoid types at that time known represented probably but a few fossil twigs of what would turn out later to be a many-branched tree of man, ape-men, and apes of the past.

On that tree were the Java ape-man, Pithecanthropus erectus, earliest offshoot from the main stem and 500,000 years old; Neandertal man, Piltdown man of England; Rhodesian man; and finally our own modern races and some of their nearer ancestors such as Boskop man, Talgai man, and Wadjak man-the widely-known Cro-Magnon man being the probable ancestral type of our own European race.

How extremely ably Sir Arthur Keith prophesied has been amply borne out by the subsequent progress of discovery In brilliant succession has come major find after major find. In and after 1927 came the several skulls found excellently preserved in caves near Peiping-Sinanthropus, or Peking man, curiously combining modern and primitive characters and contemporaneous in age with the Java ape-man. In 1932 came the 50,000year-old skull of Solo man found also in Java, a probable descendent of the Java ape-man In the same year came the discovery in Palestine of 13 whole skeletons of a race in part like Neandertal man but greater in antiquity. In 1936 and 1937 two new skulls of the Java ape-man afforded the necessary evidence to throw him out of his former ape-man status and almost into the human trend of evolution. Truly, paleoanthropology, the

In addition to these discoveries there is the remarkable series in South Africa. In 1924 at Taungs, the fossil skull of a previously unknown type of ape, much nearer to man than the chimpanzee or gorilla, was found by Dart. In 1936, at Sterkfontein, Broom, a physician-anthropologist, discovered the skull of an ape differing from the living apes and named it Plesioanthropus. In 1938 he found at Kromdraai the skull of another type of large ape and named it Paranthropus. Both are of Pleistocene age-dating from

science of ancient man, has been actively

some scores of thousands of years ago.

And now has come the cap to the climax. Supplementary finds of arm, leg, and foot bones more recently discovered by Broom show clearly that these supposed apes walked erect and were probably nearly human.

Thus the mosaic is being rapidly filled in and the picture of the evolution of man from his ancestor begins to emerge, The prediction that more and more fragments of this picture will come to light is easier today than it was when Sir Arthur Keith predicted major finds The American anthropologist Hrdlička has always urged that science was trying to build the picture on too few and uncertain fragments. In a relative sense this still remains true but the signs grow better. Prof. H H. Wilder united man and the living apes in one family, a courageous act! Since Nature must have experimented with numerous others now extinct-a whole welter of forms intermediate between man and the living apes, whose fossils are likely to be discovered-the prospect for those who will be here to watch the progress during the next 25 or 50 years is likely to be decidedly interesting.—A. G 1

If They Would Only Learn

PEDESTRIANS who are familiar with automobile operation stand a better chance of keeping out of traffic trouble than do those who lack this advantage This definite conclusion is drawn from evidence that, of the 15,000 pedestrians who are killed in traffic accidents yearly, the majority do not know how to drive.

Those who walk, of necessity or by choice, have certain rights that cannot be disputed by any fair-minded automobile driver. But it is hardly fair to all concerned to uphold these rights regardless of the inclinations or desires of the pedestrian. The one factor that must be considered is the relative maneuverability of the walker and of the motor car. While the man on foot travels at a much lower speed than the motor car, he can jump, dodge, or change direction much more rapidly than can the faster moving and more bulky motor car. Then, too, the pedestrian from his more stable vantage point is often in a much better position to judge the speed of an oncoming car and be governed accordingly, than is the driver who has so many tnings to watch at the same time.

The point is this: The driver is familiar with both walking and driving; the pedestrian often is familiar only with his own pedal means of locomotion;

would it not contribute to the peace of mind as well as to the bodily health of all if these two groups were placed on an equal footing of knowledge and hence of judgment? A start has been made in some sections where the fundamentals of automobile operation are taught in schools, thus providing the pupils with information that may later be instrumental in saving their lives.

It would be far better if every person, regardless of age, could receive the benefit of this sort of education. It is, of course, too much to hope that such a thing could be accomplished by compulsory education, but thinking people who do not own motor cars can take the lesson of statistics to heart and provide for their own safety. If these pedestrians will take the time and trouble to learn how to drive a motor car, even though they may never have occasion to do so, they will have laid a foundation of knowledge that will be as important to their futures as are the simple rules of health and sanitation. -- A. P. P.

The Implications of Science

THE demand that science help the world to utilize its accomplishments constructively, for the common social and economic good, has been so urgent during the last few years that a plan has been worked out to do just that, according to a recent announcement. However, the plans will not be revealed until after consideration by the Council of the American Association for the Advancement of Science.

Naturally, every right-thinking per son will welcome this new activity and wish its leaders well in their attempt to integrate the work of scientists. Yet we cannot suppress a certain cynicism. Science, no doubt, is far ahead of civilization, but if this is so, attention should be paid to education of the human being, not to the end-product of research Who, for example, could have foretold the bombing airplane's domination of cities or its dictation of new national boundaries; or, having done so, could have thwarted this "misuse" of a scientific product except by education? Furthermore, that the planners worked for three years "in co-operation with a Congressional committee," reminds us too much of the useless 450,000-word report of the National Resources Committee.

Perhaps our cynicism is ill-founded. We hope so. But we will look for real results and be content with nothing less. "Reformitis" for its own sake is too much for stomachs far from queasy.-F. D. M.

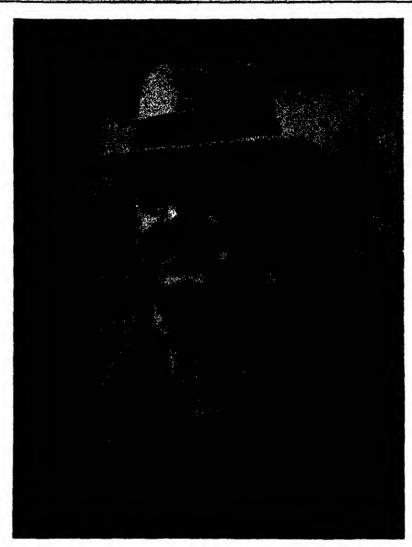
on the move.

Personalities in Science

CONFUTING an occasional American impression that in England a man's rise in rank is heavily hampered if he does not happen to belong to the right class, is the career of Sir Richard Gregory, for 20 years the editor of Nature, the world's most outstanding journal of the sciences for the professional. He began life as a newsboy, in accepted American fushion, and many years later was knighted and given the hereditary rank of baronet by the King.

Richard Arman Gregory was born in 1861 After leaving school at 12 years of age, he became in succession a newspaper boy, page boy, machine boy in a printing office, and apprentice to the boot and shoe trade. Through his studies before and after factory hours, he was brought to the notice of Dr. J. M. Wilson, then headmaster of Chiton College, and was given a minor post in the physical laboratory of the College. From there he was successful in gaining a studentship at the Royal College of Science, London, which entitled him to free tuition and a maintenance allowance of about five dollars a week. After leaving the College, he became science instructor at H M. Dockyard School, Portsmouth, but returned two years later to become a research assistant to the great astronomer, Sir Norman Lockyer, who in 1868 discovered in the Sun what was then an unknown gas, named by him helium, which was not identified on the earth until 26 years later. In 1893 Sir Richard became associated with Sir Notman as assistant editor of Nature and succeeded him as editor in 1919 For several years while engaged in the editorial work of Nature, Sir Richard was an Oxford University Extension Lecturer and professor of astronomy at Queen's College, London.

Among the academic honors conferred



SIR RICHARD GREGORY

upon Sir Richard are the doctorates of science of the Universities of Leeds and Bristol, and doctor of laws of the University of St Andrews In 1933 he was elected a Fellow of the Royal Society of London under a special statute reserved for those who "either have rendered conspictions service to the cause of science, or are such that their election would be of benefit to the Society" Only ten other living Fellows of the Royal Society, including prime ministers and peers of the realm, were elected under this statute.

His view is that the main mission of science is to cultivate a habit of mind which may be usefully presented to many problems of modern life. "When scientific work is instituted solely with the purpose of securing commercial gain," he says in his book "Discovery," "its correlative is selfishness; when it is confined to the path of a narrow specialization, it leads to arrogance; and when its purpose is materialistic domination, without regard to the spiritual needs of humanity, it is a social danger and may

become an excuse for learned barbarity."

Sir Richard's early contacts with social reformers and with the stern realities of life and labor made him familiar with the human aspects of applied science as affecting industry. This probably accounts for the attention given to the social relationships of science during his editorship of Nature, which is recognized as the leading organ of the professional scientific world. Its attitude toward social matters is that, as science is responsible for the industrial developments and economic changes which have caused violent disturbances in the social structure, and has provided also the means by which civilization may commit suicide, it has a duty to guide the human race to the wise use of the powers it has created Su Richard is regarded as the leader among British representatives of science, especially in the younger generation, in the promotion of closer relationship between science and social problems and the progress and use of scientific knowledge in the service of the world of man.



ACCURATE MACHINERY FOR BETTER TIRES

THIS huge machine, operating with a high degree of accuracy, is used in one step of the process of making the safe and efficient tires on which modern motor cars roll. It performs a calendering operation by which rubber is sheeted out thin between steel rollers, preparatory to taking its place in the assembly of tires as described on page 158. It is machines such as this, applied in the production of modern needs, that have made possible economics which result in high-grade products at low cost.



Fire-walking in India, a typical scene such as is described in the article. Fire-walking is a world-wide ceremonial rite of purification is which the performers walk barefoot across pits filled with red-hot stones or glowing embers of wood, without injury to the skin of the fee

FIRE-WALKING

SURROUNDED with superstition and mystery for centuries has been the spectacular feat of walking barefoot over highly heated stones or white-hot embers without damage to the skin or flesh. In Polynesia and India, wizards and witch-doctors long have impressed and awed their peoples by these performances, which are undertaken after prolonged purifications and with ceremonial rite.

Innumerable times have Europeans and Americans witnessed these exhibitions, sent their observations to their home newspapers and attempted to explain, either as trickery or science, the obvious immunity of the participants. Their accounts make readable narrative but, with few exceptions, they have lacked what the scientist would call "essential detail."

Scientists at last have investigated fire-walking and the secret seems to be solved. The solution is simple. The feat is stripped of its atmosphere of mystery and hoous poons. Probably you could do fire walking sciently by doing it.

fire walking simply by doing it.

There are two varieties of fire-walking and heart access and on glowing em-

When Investigated by Scientists, the Oriental and South Sea Island Feat of Walking Barefoot on Fire or Red-hot Stones Gives up its Mysterious Secrets

By ALBERT G. INGALLS

bers—stone-walking and ember-walking. Stone-walking is practiced in Polynesia—Fiji, the Cook Islands, the Society Islands, the Marquesas, the Hawaiian Islands—glamorous Pacific isles of romance. In a broad, usually circular pit of knee depth an immense wood fire is maintained for hours around stones about the size of a sofa cushion, till some of them are raised to red heat. The fire-priest, after going to all possible lengths to surround the occasion with magic and mysterious ceremony, walks barefoot over the highly heated stones. His feet are not even blistered.

Ember-walking is mainly East Indian in origin. It is, however, performed not alone in India but in other parts of the world where Indians have colonized—Trinidad, Natal, Mauritius, for example.

It is also performed in Japan. In a kneedepth, rectangular pit, perhaps six by twelve feet or even larger, many cords of wood are first burned. When the flames die down, and the large, deep bed of embers glows red-hot, the performer plods straight across it from end to end, barefoot and in no particular hurry. He reveals no pain and there are no dire results. Often he repeats the performance. Is it supernatural?

Anthropologists have long been familiar with fire-walking as a folk-custom. Frazer, in his "Golden Bough," and Andrew Lang in "Magic and Religion," landmarks in the literature of human folklore to which the anthropologist turns for reference in matters of cults and practices, describe the preparatory rites, the exercism of the fire, the re-

ligious fervor, the fasts of the sorcerers, likewise the meaning of the ceremony to primitive man. Fire is an opponent of evil—of bad health, for example. The ghost, witch, warlock, wizard, or other hobgoblin of the imagination that causes the ill, dares not pursue the victim through the fire. Good logic, if you like its premises.

PROFESSOR Langley, of the Smith-sonian Institution and early airplane fame, witnessed a stone-walking ceremony in Raiatea, near Tabiti in the Society Islands. The pit measured 21 feet in length, was nine feet wide and kneedeep. Cords of wood were placed in it and on top of the wood about 200 rounded stones of porous basalt, weigh ing from 40 to 80 pounds each, were heaped in a mound. The wood was ignited and after four hours the inner stones were red-hot and bursting with loud reports. Four times the fire priest crossed the center of the pile of stones, barefoot, unharmed. Langley removed one hot stone on which the fire-walker had stepped and dropped it into a bucket of water. It boiled the water for 12 minutes: proof that the rock was a slow conductor of heat. A good conductor of heat would cool much more rapidly-also burn the fire-walker's feet, no doubt He brought the stone to Washington and reheated it to the same hue, thereby ascer taining the temperature to have been about 1200 degrees, Fahrenheit Lead melts at 621 degrees. Only recently have scientists made more exact experiments in connection with fire-walking than this simple one of Langley's.

Percival Lowell, the astronomer, wit nessed the ember-walking rite in Japan

A pit 12 to 18 feet long was filled with charcoal which was brought to a red-hot glow. Now the priest breathes in and out of his pursed-up lips-"a great purifier" After a few consecrated words he strides with dignified unconcern over the whole length of the fire-pit-barefoot. His exorcism of the fire has quite deprived it of its power to injure. Lowell, however, preferred to explain the immunity on more rational grounds—the toughness of the man's soles, the less sensitive nervous organism of the Oriental, and the exaltation and ecstasy of the performer, a combination of the physical, the physiological, and the psychological. Now that we have the approximate answer to the question, none of these three general explanations can be wholly excluded, but one of them comes out on top, quite definitely. In advance of the final answer, how would the reader rate the three?

A few year- ago a reader of this magazine inquired whether an account of stone-walking in Tahiti, which he had read in Frederick O'Brien's "Mystic Isles of the South Seas," was really truthful or whether its author had not perhaps been under the spell of hypnotism when he witnessed the ceremony. This question was published and, as a result, eyewitness accounts of fire-walking in different corners of the earth have trickled in to the editor ever since. A reader from India, for example, offered this.

"I was an eye-witness to at least two fire-walking ceremonies and was indeed struck by the remarkable freedom from injuries which characterized the ritual At one of these which I saw at Pallavaram, in the Chingleput District, there were 18 men of ages from 18 to 65, who

participated in the ritual. The fire was about 16 feet by 12 feet by 4 feet deep and was made up of huge logs of wood which were allowed to burn for over six hours before the men went into it barefoot and with only a wet loin cloth on their person.

"These men took a bath immediately before they got into the fire, and with the wet loin cloths on their person, freely walked over the red-hot embers, chanting some weird religious songs

"The only rational—at all events, what appeared to me to be rational—explanation was that these fire-walkers smeared their bodies with the juice of some leaves, which had the remarkable property of desensitizing the skin to fire. Other explanations ascribe the freedom from injury to mystic and occult powers, and to religious fervor in the walkers, which transcended all physical feelings.

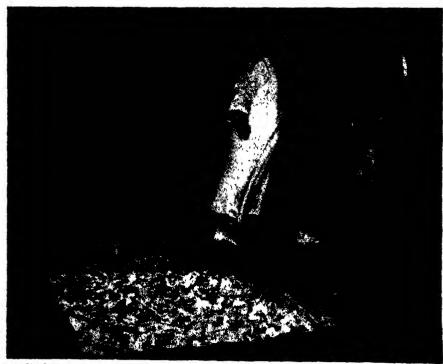
"In the second instance 55 men took part in the ceremony but only one was hurt. If the whole thing was a fake, how can we explain this observed fact of one man being injured?

"I honestly feel it is not a stunt. But, at the same time, I cannot for one moment reconcile myself to the idea that fervor, however deep, can save the victim from some bodily injury. It must therefore he some sort of anesthetic effect that is induced in the walkers by the previous application for some days or hours or even perhaps minutes, of some powerful juice which, while producing this effect, is not washed away by the bathing to which the walker subjects himself before the assembled audience -apparently to show them that they had nothing on their bodies to protect them from the fire.

"I would like that you invite a free expression of opinion on this matter from your readers over the globe."

IN Natal Province, Union of South Africa, are many East Indians, and another reader, F. Hawley Williams, of Pietermaritzburg, describes ember-walking as practiced there, "This ceremony," he writes, "is a religious penance ceremony and is carried out for the purpose of purifying the participants from sin, and to confer immunity from evil-doing in future. The candidates are required to undergo a preparation for at least ten days, during which time they are not allowed to eat meat, nor drink alcoholic liquor, nor come into contact with women. Each must bathe the whole body twice daily. Ceremonies are carried out every day at the temple and the candidates recite many prayers to their gods, prostrating themselves before the images. No drugs are administered and no treatment of the skin is given, but the majority of Indian workers do not wear boots and the soles of their feet become

"On the day of the final ceremony the



Kuda Bux, a Moslem magician from India, whose fire-walking tests are described in the text, after traversing barefoot the long fire-trench shown behind him

devotees are ceremonially bathed under the direction of a priest, in a nearby stream, while a crowd of women dressed in the sacred color—yellow—sing, dance, shout, and clap the hands, and youths play Indian musical instruments, the whole combining to make to European cars a hideous din. The devotees are next led to the temple grounds, preceded by an image of the goddess Mariamman carried on a platform on the shoulders of men, also by men beating tom-toms, playing wind instruments which produce a worse noise than bagpipes (with apologies to bagpipes), and clashing cymbals

"On arrival at the gate of the temple grounds those taking part in the firewalking are in a state of religious frenzy, leaping, shouting, and pushing to obtain a front place in the path to the fire-pit. This year 15 men took part. Immediately before the first one crossed the burning embers a goat was sacrificed by decapitation at the edge of the pit. This was about 30 feet in length, ten feet wide, and 18 inches deep and was a mass of hot wood embers, raked down fairly level.

"A PRIEST crossed the red-hot embers first, at an ordinary walking pace, followed by the devotees in twos and threes. Some of them ran with long strides, others with short, sharp steps. A few completed only a part of the total distance and, their faith failing them, they ran to the side of the pit and scrambled out. The remainder completed the course, being assisted to reach the grass verge and to stand until the hysterical condition had passed off.

"No harm came to the participants.

"As the result of a long conversation with an ex-president of the Hindu temple, Mr. J Sobiah, an educated Natalborn Indian, the writer feels that there is positively no trickery or faking connected with this ceremony, no preparation of the feet to harden the skin or in any way to cause the skin to resist the action of fire, Two Europeans submitted themselves to the ordeal, took the prescribed ten-day preparation, and one walked safely over the red-hot embers, the other having a small blister on one toe. What gives immunity from fire is not understood. The Hindus ascribe it to faith in their gods, coupled with the purification. One hears many theories advanced to account for the apparent loss of feeling-hypnosis, use of stultifying drugs, skin treatment and so on-but one must accept the word of men whose statements can be relied upon that, beyond purification, dieting, and prayer, nothing is done which can in any way account for the result. Faith is the great factor."

From Colorado another reader advances a hypothesis that is usually given consideration by most persons of scientific inclination while canvassing possible explanations for fire-walking immun-



Ahmed Hussain, another magician from India, walking across 12½ feet of red-hot embers at temperature of 1067 degrees, Fahrenheit, leading three Englishmen in their maiden fire-wa

ity A woman ironing, he suggests, will test the degree of heat by moistening the finger and touching the iron. The moisture on the finger creates a vapor cushion which protects it temporarily from being burned. Plumbers, he points out, are accustomed to direct the flow of molten lead with the bare palm of the hand, and here the same principle applies. Some moisture would be left on the body of the fire-walkers after the preliminary bath, he argues, since they probably do not use towels, and this would continue the supply of moisture after the first moisture of the bath had evaporated.

The phenomenon described is well known to scientists as the "spheroidal state of a liquid". The liquid, in drops (hence the word "spheroid"), floats on a layer of its own vapor and, though it does not itself reach boiling temperature, it rapidly evaporates from its exposed surface because of the adjacent heat. Water drops dancing on a hot stove give probably the most familiar illustration of the spheroidal state.

Unfortunately, two objections stand against this scientific phenomenon as an explanation of immunity in fire-walking First, it would be impracticable. It would be easier for a man to carry an armful of live eals the length of a day's walk than to try to make a wet loin-cloth feed a uniform supply of water down the legs to the soles of the two feet, even if no one were watching. Second, no fire-walker, unless he had temporarily lost his memory of the effects of the first attempt, would try this method a second time. The reason will appear later.

Richard Martin, of San Francisco, describes his observations: "I once saw a performance of fire-walking, and to my mind there is no mystery at all.

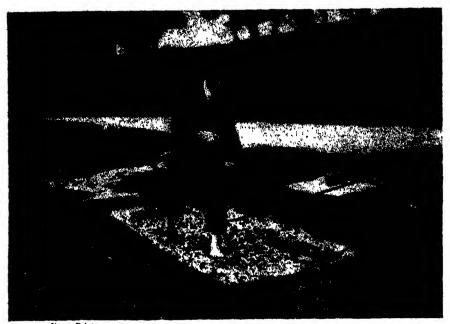
"The fire-walking took place in the South Pacific, in the island of Tahiti. It

was performed by a group of natives from the island of Raiatea. Hearing of the coming event, I questioned several of my native friends for an explanation. They all explained it upon superstitious grounds, which I did not believe, although I did not tell them so. I believed that the laws of nature could be the only explanation. I was convinced that if a native could perform it, then I could do likewise, in which I was partly wrong. I made up my mind to attempt to do all that the natives would do if nobody opposed me.

"The day of the fire-walking arrived, and I found that a pit had been dug, about 18 feet long, 12 feet wide, and three feet deep The bottom of this pit was covered with boulders about 12 or 14 inches in diameter, such as may be found in the bed of any of the streams. Upon these boulders a fire of logs was burning, with flames reaching about six feet high.

"THAT afternoon I returned to the location and found a crowd of people waiting. The fire had now been burning several hours, and was being allowed to burn itself out. The boulders were covered with red-hot coals, with low flames above them. The natives now placed the ends of long poles under the red-hot boulders, turning and prying them up, so that soon the red-hot coals were below the boulders. This caused the surface of the upper halves of the boulders to lose their redness, but the lower halves remained red.

"About six of the natives, clad only in a cotton cloth around their waists and reaching to their knees, now approached the pit in single file. The leader carried a bunch of long leaves in his hand. To natives, this kind of leaf has a superstitious meaning. Reaching the edge of



Reginald Adcock walking on a bed of entbers having a surface temperature of 1472 degrees, Fahrenheit. The English tyro equalled the Orientals' best feats

the pit the leader stopped and, turning his face toward the sky, spoke in a loud voice about two dozen words in the native language. Next he stooped and, reaching into the pit, struck one of the boulders three times with the bunch of leaves. My native friends told me that all this was necessary to prevent the performers from being burned. Without hesitation the leader now calmly stepped with bare feet on the hot boulders in the pit and walked leisurely across its 18 feet, close ly followed by his associates. After crossing the pit they repeated their walk in the opposite direction. This concluded the performance

"AS SOON as the performers were out of the pit, I stepped to its edge, barefoot, to test the heating properties of a boulder, as I had previously planned to do. Extending one leg into the pit, I placed my bare foot heavily upon a boulder, then quickly removed it. I found the conditions just about as I had expected, Immediately I stepped upon the boulders and walked across the pit with bare feet. Then I repeated the walk in the opposite direction. Although I duplicated the performance of the native fire-walkers, I admit that I did not do it in quite such a leisurely manner; in fact, I walked rather fast, and for a very good reason! I then examined my feet and found them uninjured, although they did not feel as comfortable as could be desired. Within two minutes after walking on the stones, I repeated the performance, thus walking across the pit four times. This second walk was a mistake, because upon examining my feet again I found a blister the size of a 25-cent piece on one foot; also my feet were twice as uncomfortable as before. The boulders did feel very hot, as indeed they were, but they were not unbearable.

"The boulders used were of the kind that are characteristic of this group of volcanic islands. They have the same appearance as a rubber sponge and were undoubtedly at one time molten lava filled with bubbles of gas. This structure makes them ideal as poor conductors of heat. In addition, the performer has thickened skin on the soles of his feet."

The stone-walking variety of fire walking may permit as many as 25 steps. The stones are heated red hot but usually unevenly, because the flames do not play on them evenly. Professor Langley observed that the parts that were not redhot were nevertheless very hot. Even so, stone-walking is not usually so severe a test or so difficult a feat for the same distances as ember-walking, for here only a relative few steps may be taken with immunity Usually, also, the embers are hotter than the stones used in stone-walking. At least they are hotter than the portions of the stones that are stepped on, or else there are other differences

AND now we reach the London investigations, for the first time the active participation of physicists, and the solution.

The University of London Council for Psychical Investigation consists of ten members, four of whom are professors. Its Honorary Secretary is Harry Price and its Laboratory is at University College, in the heart of London.

A few years ago the Council decided to look into the question of fire-walking and authorized Harry Price to advertise for fire-walkers. Letters arrived from many who had seen fire-walking but none wanted to try it themselves! However, an (East) Indian magician, Kuda Bux, a Mohammedan, turned up and stated that he was a fire-walker. Tests were planned. The following is quoted from

one of two reports on experimental firewalks. "The object of the experiments," Harry Price states in his report—the first of the two-"was to ascertain if Kuda Bux was immune from burning when walking over the fire; if so, why? Is fire-walking based on trickery? Can anyone do it? Do the performers prepare then feet! Can they convey their alleged immunity to other persons? Do the walkers' prepare their feet with a paste made of alum, salt, soap, and soda, as has been alleged? Do they have to be in an ecstatic or exalted condition? Do they have to possess faith? Do they inject an ane-thetic into their feet? Do the wood ashes form an insulating layer on top of the fire, and thus prevent burning! Does the performer have to hurry along the trench, or can be stroll? Does he fast or otherwise prepare himself -mentally or physically-for the ordeal? Kuda Bux stated that his immunity from burns was due to faith. He also claimed he could convey his immunity to another and take him over the fire without in-

TRENCH one foot deep, three feet A MENCH one took deep, three feet wide and 25 feet long was dug. Three tons of wood were laid in it and on the appointed day this was ignited. After an hour and a half, a load of charcoul was added, an idea of Harry Price's, in order to make a hotter, cleaner, and smoother surface. After three and a half hours from the beginning these fuels had burned to a glowing mass of red and black embers three inches deep. This was too shallow, but the researchers were unacquainted with fire-walking and in this and other ways on their first attempt to provide suitable conditions they did not quite attain the desired ideal. Kuda Bux said he preferred at least nine inches of embers. He could give no clear reason for this but alleged that it was much easier to walk on several layers of embers than on a thin layer of fire. However, he walked.

Before the test Kuda Bux's feet were examined by Dr. William Collier, of Oxford, who was present and pronounced his feet normal. Swabs were then taken and handed to a pathologist for analysis but snothing was found. One foot was then washed, evidently as a check or control on the other, in case of some substance having been applied.

Kuda Bux stood at the end of the trench and muttered a prayer from the Koran. He then stepped on the fire and took four steps, each foot making contact twice. He did not run, but walked (Please turn to page 173)

1"A Report on Two Experimental Fire-walks,"
Bulletin II of the University of London Council for Psychical Investigation, by Harry Price;
"A Report on Three Experimental Fire-walks,"
Bulletin IV, by G. Burniston Brown, M. Bc.,
Ph.D.; respectively 5/- net and 1/- net, or \$1.25
and \$.25, foreign. Rooms of the University of
London Council for Psychical Investigation,
19 Berkeley St., Mayfair, London W.1, Engiand.
Not available direct from Scientific American.

An Electrical Voice

Speech Created . . . Skilled Operation Requires Long Training Period . . . Result of Research

BUILT almost entirely of apparatus used in everyday telephone scrvice, an electrical device which, under control of an operator at a keyboard, actually talks, is a development of Bell Telephone Laboratories. It was designed as a scientific novelty to make an educational exhibit for display at the San Francisco Exposition and at the World's Fair in New York.

The Voder, as the device is known, creates speech. It is the first machine in the world to do that. Individual vowels and consonants have been made by a variety of instruments, but they have never been linked into connected speech, Seated at a keyboard something like that of the oldfashioned parlor organ, an operator can carry on a conversation simply by pressing keys, singly or in combination. It takes a good deal of practice and some time to learn-not as much time as it takes the human to learn the mechanisms he is born with, but still quite a while. And it talks with what might be called a slight electrical accent Nevertheless a skilled operator can make it -ay what she wants.

Designers of the Voder provided it with electrical equipment corresponding to the two kinds of speech sounds. One kind of sound is made by forcing the breath through the mouth, past tongue, teeth, and hips. Turbulence in the airstream sets up a hissing sound which contains a great many vibration-frequencies. Some of these are reinforced by resonances in the mouth cavity; that is the way in which are made all the sounds



Ten of the white keys each control a speech sound; the eleventh is for volume. The three black keys make the "stop" consonants. The wrist switch changes from consonants to vowels

of speech when one whispers, and such sounds as "s," 'th" and "f." In the Voder there is an electrical hiss, and with some of the keys the operator can control its quality so as to make those sounds. Other keys make the "stop" consonants like "d," "k," and "p."

Another kind of sound enters into human speech, most importantly in the vowels, like "a," "c" and "o." It comes from the vocal cords, and is very complex and somewhat musical. In the Voder, there is an

electrical source of sound corresponding to the vocal cords, and there is a pedal for changing its pitch and for giving to speech a rising or falling inflection as desired. When the operator wants the sounds made by the vocal cords, instead of whispered sounds or consonants, an arm rest switch is depressed. Then the particular parts of this vocalized sound which are wanted are selected by pressing the proper keys

THE source for this sound is the socalled "relaxation oscillator" which gives a saw-toothed wave in contrast to the smoothly rounded wave of a pure musical note. This saw-toothed wave has a fundamental note which gives the whole sound a definite pitch. Broad changes in this pitch mark the difference between male and female voices; gliding

change of pitch over a smaller range constitutes inflection. The Voder may be posed as a man or a woman by turning a knob, it may state a fact, ask a question, or emphasize a word according to the motion of its pedal.

When one talks, one shapes his mouth cavity so that some particular parts of the complex sound come through clearly while other parts are suppressed and unheard. This makes the difference between the vowel sounds. For the same purpose the Voder is provided with ten keys. Each of these controls the current in a definite frequency range.

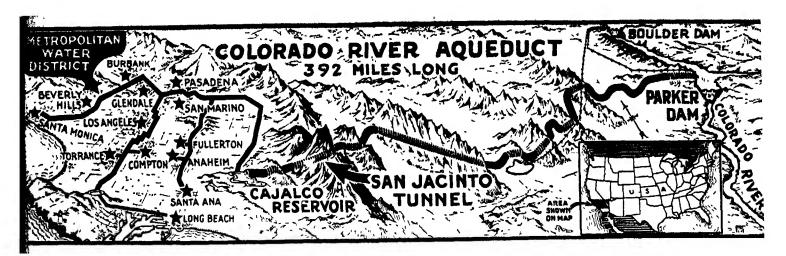


The Voder in operation. Foot pedal gives inflection to synthesized speech from loudspeaker

Source of current for each attenuator is an electrical filter which picks from the saw-tooth wave one particular group of its overtones. The Voder seems to speak most understandably when unimportant overtones are suppressed.

Considering all the keys, there are 23 different sounds available to the Voder operator. By combinations of keys she can mix these sounds and by the fingering she can control the shading. All speech sounds can be produced, but the number any operator can make use of depends on her finger dexterity; even granted the ability, only long practice will bring skill.

The Voder is an outgrowth of fundamental researches in telephony carried on in Bell Telephone Laboratories as part of this program. Homer W. Dudley, in the course of one of these researches, developed a speech synthesizer which could be controlled electrically by a speech analyzer. When the Bell System exhibits were projected for the Expositions at San Francisco and New York, the synthesizer part of the apparatus seemed to offer possibilities for development into a demonstration which would have educational value since through its use the formation of speech sounds could be shown. Mr. Dudley and R. R. Riesz thereupon constructed a model which has been put into form for exhibition by W. A. MacNair of the Laboratories' technical staff. Difficult tasks of working out its linguistic possibilities and a technique for its operation were undertaken by S. S. A. Watkins, who developed a course of training and instructed a corps of operators.



Boring Through a Rainstorm

HIRTY-SIX million gallons of water pouring down through the rocks of Mt. San Jacinto in Southern Cali forma every day ... Underground rainstorms which heat unceasingly against several hundred workers.... Solid tock, shifting rock, and unconsolidated rock which threatened constantly to fill the 13.2-mile tunnel being driven through those storms. Yet hard rock miners pressed ahead through the downpour, completing recently the dramatic job of boring the long hole through which even tually a billion gallons of water will flow on its 392-mile journey from the Colo-1ado river to Southern California

San Jacinto is one of 38 major tunnels on the Colorado River Aqueduct system. Totaling 108 miles in length, these have constituted one of the biggest tunneling jobs in construction history. Much of the 392-mile aqueduct system has been con-

San Jacinto Tunnel, Part of Colorado River Aqueduct System, Presented Engineering Difficulties . . . Rock and Water . . . Pioneer Tunnels Driven Ahead

By LYNN DAVIS SMITH
Metropolitan Water District

structed without strenuous opposition both from the forces of nature, she seemed to concentrate most of her might at one. Follow

point—Mt San Jacinto. This spectacular peak, which, with its foot in the desert only 400 feet above sea level, rises a sheer two miles into the air, is a fitting spot for a show-down fight between man and nature. For her principal weapon against man, nature chose the very thing that he will carry through that mountain

Water was encountered when sinking

both the Cabazon and Potrcio shafts from which the tunnel was to be bored Following several delays, construction was started on large-capacity pumping facilities at both shafts. These consisted of large bottle-shaped chambers cut out of the solid rock adjacent to the two shafts, Batteries of pumps having a total capacity of 29,600 gallons per minute at Cabazon and 17,400 gallons per minute at Potrcio were installed in these chambers.

Auxiliary controls on the surface were provided so that the pumps, in their water-tight chambers, could be operated even though the tunnel should be completely flooded. Large steel pipe lines ran from these stations to the tunnel headings. The pumps continued to operate until Cabazon holed through to the east portal and Potrero holed through to the west portal, after which the water was carried through the tunnel and out at the portals.

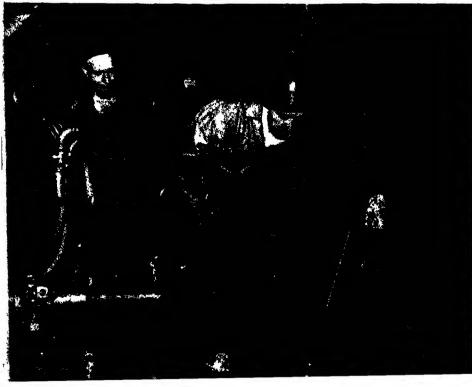
WITH adequate pumping facilities installed, the hard-tockers once more turned their attention to driving headings. Work continued in the tunnel 24 hours a day, seven days a week, the two exceptions being Christmas and the Fourth of July.

Working in high-pressure water, four to eight men were needed to change drill steels. Holes at the bottom of the face had to be drilled under water. Sticks of dynamite had to be strapped to poles and the poles wedged into the drill holes so that the powder would stay in place long enough to be fired.

The greatest amount of water encoun-

'rotected against falling rock fragments by "hard-boiled" hats, and against water by ramouts and boots, the drill workers pushed ahead in the hard rock through which water poured

-waler



tered at a working face was in East Potrero, where it once reached a peak of 15,800 gallons per minute. Oddly enough, as though the old man of the mountain had found that even this didn't stop the crews, the heading almost immediately advanced into a dry section. So decided was this change that the front of the drill jumbo was completely dry, while the back end was being doused with 10,000 gallons of water per minute

For the purpose of reducing the length of time required to excavate the tunnel, an additional access point was constructed. This is known as the Lawrence adit, and is located approximately midway between the Cabazon and Potrero shafts.

This adit, which is a mile long, is built on a 25 percent grade, and drops 1324 feet from its portal to its intersection with the line of the main tunnel. The adit was completed three months ahead of schedule, and headings were immediately started east toward Cabazon and west toward Potrero

About the time that construction of the Lawrence adit was started, both the Cabazon and Potrero headings were in heavy going. The engineers then decided to use pioneer tunnels paralleling the main tunnel These pioneers are 10 feet square and were driven south of and parallel to the main headings, which, by this time, had both been angled north to intersect the Lawrence adit. In bad ground, these pioneers immediately proved their advantage. Being smaller, they were driven faster and thus were able to get considerably ahead of the main headings. This made it possible to explore the ground in advance and also to shoot cross drifts over to the line of the main tunnel, from which new headings could be put into operation.

WHEN the main heading at Cabazon had crossed all known major faults between Cabazon and Lawrence, and the Potrero main heading was able to keep pace with its pioneer, it was possible to suspend pioneer operations, although all equipment was still maintained, ready for immediate use should heavy water flows or broken ground again make its use advantageous.

Throughout the course of work on the San Jacinto Tunnel, the engineers were constantly confronted with problems that affected every man on the job and which had to be solved quickly and efficiently before the fight against nature could be carried on.

Today, with rock-moving in the tunnel completed, it is impossible for the average visitor—unless he himself is a tunnel man—to realize the tremendous odds that have been overcome in this battle against the mountain. As he speeds along on the tunnel train, mile after mile, his principal impression is of the seemingly unending length of the bore. The scars of battle have largely been covered



A common sight during the boring of the San Jacinto tunnel was a downpour of water such this. At one time the inflow to the tunnel at the working face was 15,800 gallons per minu

over, for more than seven miles of the tunnel have already been lined with concrete and completed.

His guide may stop the train in an unlined section and point out giant timbers, 16 inches square and standing together "skin tight." Here a few months, or a few years, ago the heading was brought to a standstill—for a day or for weeks—while the hard-rockers battled water and heavy ground. Ground so heavy that it crushed huge timbers as though they were matchwood, and bent and twisted heavy steel ribs into grotesque shapes. It required the heaviest timbers available, standing together as tight as they would go, to hold the mountain in its place at such points

and keep the tunnel clear of debris.

A little farther along, the train may stop in a section where the visitor is told that this is good ground, and here the tace was advanced 40 feet in a single day. Here the gray granite stands clean and unsupported, and the crews drove "full face" with eleven drills working on the heading at one time. Eleven drills working in a solid rock chamber, 18 feet square, and each drill making more noise than a machine gun!

But those noises are silenced now. Drills no longer sputter and rattle. The big hore is finished except for lining with concrete. Another few months will see it ready to receive water.

One of the outlets from the huge pumps that kept the tunnel relatively free from water. times, more than 36,000,000 gallons of water a day flowed into the tunnel through the ro



As Astronomers Meet

CCIENTIFIC societies are sometimes criticized for devoting their attention to one narrow field, but anyone who listened to such a list of papers as were presented before the recent meeting of the American Astronomical Society in New York could hardly repeat this charge. Half the range of human knowledge seemed to be represented from the utmost limits of the Milky Way to the internal structure of atoms, from simple - and beautiful - photographs showing the stars in their natural colors, to the intricacies of mathematical theory, from a star 100,000 times as bright as the Sun to the feeble flash of meteors ---vet all had a direct connection with the science.

Beginning "at home," we may note an interesting report by Dr. Wooland of the Weather Bureau on the influences which modify climate If the Earth's surface, like the Moon's, had practically no pow er of storing up the Sun's heat, the longest day of Summer would be the hottest, and every night cold Also the South Pole in its midsummer would be the hottest place in the world. Storage of heat, mainly in the ocean waters, modifies this profoundly. In the deserts along the Mexican border, the hottest temperature of the year comes, on the average, ten days after the summer solstice; on the California coast near San Francisco the year's hottest weather comes three months later! A hundred miles inland, the lag is very much less. When the great major seasonal variations are so profoundly influenced by local conditions, it is no wonder that the minute and barely measurable changes in solar radiation connected with the sunspot cycle have no practically perceptible effects

Next in order of distance should come Whipple's studies of meteors from photographs taken at Harvard. If one turns a camera on the stars for an hour or two there is not one chance in a hundred that a meteor bright enough to record its passage will flash across the field of view. But when the stars are systematically being photographed for other purposes, two cameras, at Cambridge and Oak Ridge, 25 miles apart, can be pointed at the same part of the sky-or more precisely, toward a point 50 miles or so up in the air, at the level where meteors appear. Once in a while a meteor will he caught and the converging lines drawn from the two stations to points upon its path suffice for an accurate survey of its position in space

Moreover, by arranging a narrow re-

Among Themselves Astronomers Specialize On a Wide Variety of Problems, and Then Meet Twice Yearly to Tell Each Other About Their Researches

By HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University Revearch Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

volving shutter which cuts off the light for an instant 20 times every second the speed of the meteor on its path can also be found. Four meteors recently ob served, whose lines of flight, when they met the Earth, were almost parallel in direction, were thus found to have al most exactly the same speed, relatively to the Sun, and to have been moving in orbits of nearly the same size and shape, similar to those of short period comets It is, of course, no news that meteor swarms of this kind exist; but the observation of individual meteors with such precision that their orbits may be accurately calculated is something new, and opens up an important line of regular work for the future. In particular, if the orbits of meteors belonging to our solar system can be calculated accurately, it will be possible to be quite certain in other cases that meteors have come in from interstellar space. Little clear evidence of such invaders has yet been secured, but more may be anticipated as the work goes on

LARGE-SCALE photographs of the Moon, showing very fine detail. were described by Burns of the Allegheny Observatory, and color-photographs of the recent lunar eclipse by Stokley and by Hoffman. A more unusual observation dealing with the Moon comes from Mount Wilson, When a star disappears in occultation, it vanishes instantaneously, so far as the eye can see-that is, within not much more than a tenth of a second. Now the Moon's motion in the sky is about half a second of arc in a second of time, or 0".05 in a tenth of a second. Even a huge star like Antares, with an angular diameter of 0".04, would disappear in one twelfth of a second. But modern electrical recording devices can observe far more rapid changes. Putting a sensitive photocell at the focus of the 100. inch telescope, and connecting it by a series of amplifiers with a device recording on a rapidly moving film, Whitford has found that the disappearance of the

3rd magnitude star β Capricorni was by no means instantaneous, but took more than a hundredth of a second. The changes in light look at first sight very strange -- a slight drop, a rise a little above normal, and then a rapid and deep fall to disappearance. But this, too, was anticipated. Since light consists of waves, the shadow of a clean-cut straightedge is not perfectly sharp but is bordered on the outside by faint diffraction fringes, while inside the geometrical limit the light falls off gradually. This has been a familiar laboratory experiment for a century—the fringes being so narrow that they require a magnifier to observe them But with the shadowcasting edge at the Moon's distance, the width of the first bright fringe is about 60 feet, and, as the shadow is carried by the Moon's motion, this will take about one fiftieth of a second to pass over the observing telescope. The exact calculation of the changes of light is complicated, since the observing cell is sensitive to light of very different wavelengths, whose effect must be separately computed and added. When this was done the observed curve agreed very closely with the calculated. If the star itself has a perceptible diameter, the shape of the curve will be somewhat changed; and there is hope that, in this way, star-diameters too small to reach in any other way may be measured.

One might suppose that when the occultation was almost a grazing one, and the star disappeared obliquely behind the Moon's limb, the time-scale would be drawn out and the observations increased in precision. This would happen if the Moon's surface was smooth; but the effective part of the Moon's edge, at a given moment, is not more than a quarter of a mile long, and the surface is so rough that this might be inclined at almost any angle.

Our nearest planetary neighbor, Venus, was the subject of a noteworthy paper by E. C. Slipher of the Lowell Observatory—the most experienced photographic observer of the planets. At

rot: pats

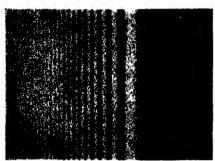
her conjunction last November Venus was only 3 degrees from the Sun. In this position the planet's atmosphere, illuminated by the Sun's light coming from almost directly behind, can be seen as a luminous ring, completely surrounding the disk. This, again, is not a new thing; it was first seen by Rittenhouse in 1769, and has been observed several times since. But the ring phase has never been photographed before, nor seen when Venus was so far from the Sun. The clear Arizona air at the high altitude has probably something to do with this success; but only great observational skill could have succeeded in getting successful photographs with blue light as well as red, despite the foreground of intense light from our sky. The permanent record of this elusive phenomenon should increase our knowledge of Venus' atmosphere. Indeed, it already appears that the hazy layer in it which is lit up brightly enough to be seen in broad daylight was of variable depth from place to place and day to day.

VERY different side of planetary A study appeared in Brouwer's announcement of a new calculation of the orbits of Uranus and Neptune. Our present knowledge of the orbits of the planets, out to and including Saturn, is very accurate, but Neptune was discovered in 1846, and had been observed over little more than a quarter of its orbit when Newcomb calculated the existing tables of its motion. Any minute errors in the observations of this limited are would be greatly magnified in the predicted positions for the unobserved portion, and so it is no discredit to Newcomb's work that his tables now disagree by five seconds of aic with the observed position. Most of this discrepancy can be removed by small changes in the assumed size and shape of the orbit, without seriously affecting the agreement of calculation with the older observations. But to obtain tables which may be trusted for prediction as long as possible, it will be necessary to repeat the whole laborious calculation of the perturbations of Neptune by the attraction of the other planets-and also to revise the present tables of Uranus, which show smaller errors of the same sort. The very extensive calculations can be greatly shortened by the use of computing machines of the punched-card type, and the work will be done at the bureau recently established at Columbia University by the friendly co-operation of the manufacturer of these machines.

Solar problems were represented, among others, by Menzel's suggestion that the force which holds up the prominences may be radiation pressure, provided that the hydrogen lines in the extreme ultra-violet (the Lyman series) are bright in the solar spectrum. (We

cannot test this directly, because the Earth's atmosphere is opaque to such light.) This may explain also why masses of hydrogen are observed to be driven away from the Sun at nearly constant speed, despite the powerful pull of gravitation.

Coming to the stars, a series of papers by several authors may be noted, dealing with eclipsing variables. By careful ob-



As Professor Russell mentions in his article, diffraction patterns usually are so fine as to require magnification to be seen. Here, however, is a diffraction pattern made with a straight-edge and much larger than is common. It was photographed by Prof. Mason E Hufford, of Indiana University, under arrangements comparable with those in which the Moon is the straight-edge: The lightsource (monochromatic) was 110 feet and the straight-edge 55 feet from the plate. The result was as many as 40 dark fringes visible on the original plate. (The fine mesh pattern on the illustration is an extraneous feature due to reproducing one half-tone from another half-tone —in this case from the one published in The Journal of the Optical Society of America, December, 1937, from which the photograph is taken and in which other photographs of broad diffraction bands are shown)

servation of stars of this sort we can find out many things which can not be determined otherwise.

For example, when the stars of a pair are close together, they are pulled out by their mutual attraction into egg-shaped forms, with their long ends pointing toward one another. When these bodies are seen broadside on, half way between eclipses, the total light is naturally greater than when they appear nearly end on, just outside eclipse. From accurate photometric observations, we may find the amount of this ellipticity. But theory shows that the shape produced by the tidal forces will depend not only on the sizes, masses, and distance apart of the stars, but on the distribution of density inside them. A star with the material greatly concentrated toward the center will be less elliptical—other things being equal-than a homogeneous mass. Calculations on this basis indicate that the increase of density toward the center is small. But another effect of the elliptical form is that, if the orbit is eccentric, the

point of closest approach of the stars will gradually move forward along the orbit. Sterne, of Harvard, from an extensive discussion of the rather complicated theory, finds that, for the two stars of this sort which have so far been fully observed, the density at the center must be about 50 times the mean density.

A way out of the discordance appears in a note by the present writer. The theory of the escape of radiation from a star indicates that, on an egg-shaped star, the surface should be brightest at the points nearest the center-where the force of gravity is greatest-and least at the ends. When we see the star end-on, the less luminous portions fill most of the visible disk; when it is side-on, the brighter parts do so, thus increasing the range of variation. Allowance for this, and also for the fact that, like the Sun, the star's disk should appear brighter at the center than at the edge, removes the discrepancy

Kopal, of Prague-now working at Harvard--pointed out that, in some eclipsing pairs, the observed ellipticity effect is smaller than might be expected, and explained this on the very reasonable assumption that one star of the pair had "broken away from the tidal control of the other, and was rotating more rapidly- in which case, though flattened at the poles, it would not be egg-shaped." Hall, of Amherst, presented observations of our old friend Algol-in the infra-red with modern plates -showing that the loss of light at the principal eclipse, when the small hot star is partially eclipsed by its companion, was less, and that at the other eclipse greater, than for visual light -which adds confirmation to the proof that the companion is redder, and therefore cooler, than the primary.

Mcl.AUGHLIN reported from Michigan on the remarkable star Upsilon Sagittarii. From the peculiarities of its spectrum, which is like that of the supergiant Alpha Cygni, but much "more so", it has long been suspected that this is a very bright object. The interstellar calcium lines in its spectrum are very strong and from this McLaughlin estimates that the distance is 2000 parsecs—6500 lightyears, and the absolute magnitude —7, or about 60.000 times the brightness of the Sun, and comparable with the brightest stars in the Magellanic Clouds.

Shapley, from the Harvard studies of faint variable stars, has found evidence that there are scattered stars extending to a distance of at least 35,000 light-years on each side of the plane of the Milky Way. Though so remote they belong to our system.

Though incomplete, this sketch of what the astronomers told one another in two days' meetings may give some idea of the present activity, and of its varied range.—Princeton University, January 5, 1939.

Pollution Kills Fish

POLLUTION in streams tends to increase with population. New and expanding industries produce an irregular but progressive pollution invasion of once clean streams, while an increasing number of people seek recreation in sports fishing in National, State, and local parks and forests and on private estates and properties, and commercial fishermen continue their age old efforts to obtain a "catch"

The problem of stream pollution is, therefore, of direct concern to those who gain a livelihood in the fisheries industries, to consumers of shellfish and fin fish, and to those who at intervals fortily their health and strength with recreational fishing

The value of the catch of 40 species of edible fish, as reported by the U/S Bureau of Fisheries in 1934, was \$70,905,000. About 73 percent of this income was derived from species of fish that may be subject in greater or less extent to the effects of coastal pollution.

In the vicinity of large cities which discharge sewage into tidal estuaries, the damage is greatest. For example, near New York City approximately 105,000 acres of productive shellfish areas have been closed, including Raritan, Jamaica, and Newark Bays, Kill Van Kull, Arthur Kill, East River, Harlem River, Hudson River as far as Yonkers, and portions of Long Island Sound beyond the Connecticut line. Near Norfolk, Virginia, approximately 38,400 acres, including all of Hampton Roads, have been closed. Some of the areas are valued at several hundred dollars per acre. The cities of Providence, Rhode Island, and Baltimore, Maryland, located near important shellfish growing areas, have spent large sums for sewage treatment works. Where the river carrying the sewage flows relatively long distances before it reaches the tidal estuary, as in the case of Philadelphia and Washington, D. C., less damage is done from the standpoint of destroying shellfish beds because the river has a chance to purify itself before it reaches the shellfish growing areas.

INDUSTRIAL wastes, on the other hand, sometimes objectionable in high dilutions and difficult to treat, may remain potent over long periods of time and may affect both aquatic life and domestic water supplies at relatively long distances from the source of pollution.

While this subject is only one phase of the broad problem of water pollution,

Industrial Wastes, Sewage, Mine Waters Pollute Rivers, Harbors... Fin Fish, Shellfish Seriously Affected... Research Needed To Correct Evil

By L. M. FISHER

Senior Sanitary Engineer U S Public Health Service Interstate Sanitary District No 2 Washington D C

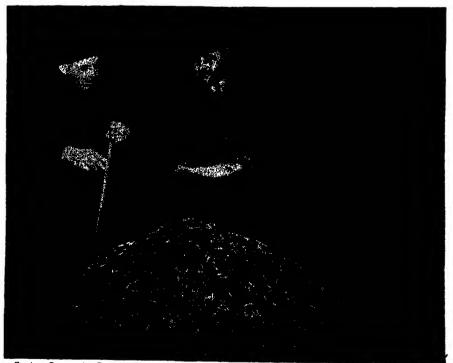
it is important, since it deals with a direct effect on public health in that shell fish have been involved more or less frequently in the spread of disease. It deals with an indirect effect on public health in that trade wastes and sewage tend to make certain valuable sea foods scarcer and more expensive, thus depriving a portion of the population of the benefits of foods rich in iodine, iron, copper, and other essential food elements and vita-

Among the causes of the progressive but irregular increase in pollution of streams by industrial wastes are the re-establishment of the fermentation industries discharging exhausted mash, the sudden growth of the cellulose textile industry with its spent chemical wastes, the development of the mid-continental oil fields, and the gradual extension of mining, the latter industry contributing vast quantities of dilute sulfuric acid

produced by the action of air and water on exposed sulfur compounds in the mines

Twenty years ago, all the tributaries of the Ohio River, with the single exception of the Monongahela, were alkaline Now the Allegheny in Pennsylvania, an I many of the streams in West Virginia are acid most of the time, and the acid line in the Ohio River is being extended farther down each year, although the mine-sealing operations recently under taken give promise of retarding this encroachment Another invasion by tradewaste pollution may be expected in southern streams and coastal waters as a result of the recently developed process for manufacturing paper pulp from slash pine, resulting in the discharge of chemical wastes and paper fiber into our

While water is being polluted by trade wastes throughout the whole country, the



Countery Conservation Department, State of New York

A sample of what stream pollution can do and often does. Millions of fish, some of
them quite lurge, were destroyed in the Niagara River from this cause in one year

'rote oats



Entrances to abandoned coal mines scaled to exclude an and thus prevent formation of sulfuric acid which has seeped into nearby rivers and acidified them

problem is more acute, generally speaking, in the section north of the Ohio and Potomac Rivers and east of the Mississippi River which contains 65 percent of the total urban population.

Sewage and industrial wastes affect shellfish and fin fish directly in one or more of several ways. They may decrease the oxygen content of the water to a point below which fish life cannot be sustained (usually stated to be about 2 parts of oxygen to a million parts of water). They may destroy fish by increasing the acidity, alkalinity, or salt content of the water, or by introducing poisonous substances; or they may increase the turbidity so as to exclude light and prevent the growth of food. Again, they may deposit a blanket of fibers and waste material on the bottom of the stream so as to destroy the fish food found there. Some wastes impart disagreeable or repulsive odors or flavors to fish or shellhsh, and others produce unnatural discoloration which makes the fish objectionable to would-be consumers.

THE most frequent offenders in decreasing the oxygen content of wa ters are domestic sewages and those industrial wastes containing large quantities of organic matter, such as the scouring water and milk wastes from dairies; blood and offal from packing plants; blood and offal from packing plants; hulls, vegetable pulp, and wash water from canning plants and beet sugar plants; spent mash from breweries and distilleries; sawdust from sawmills; wool scourings, grease, and dyes from textile plants.

The polluting material which reaches our streams in the greatest volume, and which is detrimental to fish over the largest stream-bed area, is probably acid mine wastes coming principally from

coal mines. There are thousands of mines, both active and abandoned, discharging acid drainage which in the aggregate amounts to thousands of tons of concentrated sulfuric acid daily. A considerable reduction in acid from abandoned mines has been effected in recent years by a WPA mine-sealing project sponsored by various state health departments.

Discharge of sewage into our streams or coastal waters, in addition to decreasing the oxygen content of the water, may result in forming sludge deposits on the bottom, and films of grease and scum on the surface, which tend to interfere with the absorption of oxygen from the air and to destroy small forms of aquatic life. Not infrequently, sewage contains industrial wastes and poisons, discharged either by design or accident Such substances may cause great destruction to fish life—as occurred at Buffalo, New York, in November and December, 1937, when hundreds of tons of fish, valued at more than a million and a half dollars, were killed by the discharge of poisonous industrial wastes.

Municipal sewage frequently contains oil from garages and industries-in some instances in sufficient amount to interfere with fish life. In coastal waters the principal sources of oil are probably the bilge water of vessels, leaks in oil storage tanks, refineries, and uncontrolled oil wells. The oil has a two-fold effect on oysters and other shellfish. It retards and interferes with the propagation of diatoms, which constitute the principal diet of many mollusks; and it reduces the rate of feeding by exerting a narcotizing effect on the feeding mechanism. The water-soluble substances impart an oily flavor to the meat, rendering sea food from oil-polluted water unsalable. It also destroys fish spawn and fiv.

When domestic sewage reaches shellfish-growing areas in sufficient concen trations and freshness, it may contami nate the bivalves with disease-producing organisms. In numerous instances, shell fish so contaminated have been held responsible for the spread of disease. The most recent large epidemic of this type m the United States occurred in the winter of 1924-1925, when several hundred cases of typhoid fever in Chicago, New York, and other cities were ascribed to contaminated oysters. The wide publicity given this outbreak destroyed the market for shellfish overnight, and the Public Health Service was requested to assist in restoring public confidence in the safety of shellfish as a food, As a result of this request, the Public Health Service formulated minimum requirements for the sanitation of the shellfish industry. The various states have adopted regulations at least equal to the minimum requirements, and issue certificates good for one season only to shellfish dealers who comply with the standards. These certificates are listed by the Public Health Service as long as it has confidence in the effectiveness of the contiol measures of the various states, and copies of the list are supplied to state and local health authorities throughout the country. Municipal health authorities are usually quick to exclude from their markets shellfish not obtained from shippers on the lists of the Public Health Service. This plan has been in operation for 12 years and has provided effective control

SHELLFISH grow extensively only in protected coastal waters receiving the runoff from large rivers. These areas are definitely limited; they cannot be appreciably increased or extended. Hence, the character of the wastes discharged into streams tributary to them is of great importance. A number of these areas are now so contaminated with domestic sewage that shellfish cannot be marketed from them directly. Their existence is a constant threat to the health of consumers in our coastal states because of the surreptitious taking of shellfish from them by individual poachers.

Fiber wastes and chemical wastes constitute the chief sources of pollution from pulp mills. The fibers eventually deposit on the bottom of streams a blanket of imponderable material which stops the normal growth of plant and animal life.

Mercaptans, which are sulfur ethers, or alcohols, found in the cooking process in sulfate pulping operations, have a very disagreeable odor and have been found poisonous to fish in concentrations as low as one part per million. They impair the nervous system of fish so that death eventually results.

The waste liquor from sulfite processes quite readily combines with the dissolved oxygen in the stream into which it is discharged. It also has an acidifying effect on the water and may introduce compounds of a poisonous character, such as the lignin salts.

Several detailed studies of the effects of pulp mill wastes on oysters have been made--among them one in Puget Sound

pulp mill waste in the water is the cause of the failure of oysters to grow and fatten in the upper part of the river and that the elimination of pulp mill pollution is a prerequisite for the restoration of the oyster industry in the York River."

At present the paper industry is engaged in studies to discover useful byproducts which can be made from pulp



Symbolic of our great shellfish industry, a pile of oyster shells. Already a number of large oyster beds have been abandoned because of water pollution

at Oakland Bay, Washington, and another on the York River in Virginia.

In the Puget Sound study, it was found that sulfite liquor, when added to sea water in concentrations of 0.5 to 10 parts per thousand, is decidedly unfavorable to oysters, and in the laboratory produced death in from 2 to 29 days, depending upon the concentration. The report that followed the investigation recommended that pulp mills using the sulfite process should totally exclude their waste liquor from waters in which oysters are grown

ON the York River, Virginia, the ov-ster industry has been declining markedly during the past two decades, according to reports, but it was not until 1935 that sufficient funds were available to establish a field laboratory to make systematic ecological observations and physiological experiments. The results indicate the existence of an environment in the upper part of the York River that is decidedly harmful to oysters, and physiological experiments yield direct evidence of the harmful effects of pulpmill effluent, reducing both the number of hours of feeding and the rate. Oysters taken from polluted areas in the York River and planted in clean waters improved markedly; glycogen content, which fairly expresses the quality of the meat, increased to normal levels. Shells were strengthened by deposition of lime, and growth was resumed.

The conclusion is reached by the Bureau of Fisheries that "the presence of

mill wastes, as well as methods which can be economically employed to keep objectionable wastes from streams. As a result of this research, sulfite waste liquoi may eventually become an important chemical raw material, and some progress in reducing the quantity and destructiveness of sulfate wastes is apparently also being made.

Of the sulfite waste liquor, 65 percent is fermentable. Bakers' yeast is prepared by neutralizing the waste liquor, inoculating it with yeast, and allowing this to grow under carefully controlled conditions. Approximately 20,000 pounds per week are being produced at one plant in Nova Scotia, and equipment to dou ble the output has been installed

In Washington, one pulp and paper mill sprays the waste liquor down a stack 120 feet high, concentrating it to about 50 percent solids, and sells the product as a binder for secondary roads. Concentrated sulfite liquor also has some uses as an adhesive and forms the base for most of the linoleum cements on the market. It also can be burned in a manner similar to fuel oil, but while this is practical from the viewpoint of pollution prevention, it is inefficient from the viewpoint of chemical utilization Other products, such as tanning extracts, phenol, vanillin, and fertilizer material can be obtained by precipitation methods, it is reported.

Industry is essential to the continued existence of modern civilization Without industry, present standards of living could not be maintained. Practically all our wealth, as represented by goods, is produced by industry. However, those industries which provide food to sustain life are basic and must exist before the production of goods can be undertaken. Because of this it seems reasonable that we should be interested in taking such steps as may be necessary to safeguard a natural food resource, responsible for producing such an important item in our food supply as fish and shellfish; and further it seems logical to conclude that no private industry should be permitted to damage or destroy another existing industry by the discharge of harmful wastes. The principal cost of carrying on research work to discover profitable methods for utilizing wastes or economical methods for disposing of them haimlessly should fall upon the industry responsible for their production It should be recognized. however, that there is a large public in terest involved

RESFARCH laboratories adequately financed with public funds should be able to evolve methods for recovering profitable by-products. Patent rights could then be issued to the government. making the processes available to all without the payment of royalties. It is conceivable that in this way sufficient returns to the public might accrue to repay fully the expenditure Money spent for such work should not be considered as just another form of government spending, but as an investment for the welfare of the people, who benefit from a judiclous use of the country's resources. The principal source of public funds for studying such a research problem should, perhaps, be the industries themselves, but their contributions should be supplemented by other public funds.

. In all fairness, the issuing of summary orders to effect abatement of stream pollution should be limited, for the time being, to those industries for the treatment of whose wastes feasible methods are now available Also, all units of a given industry, regardless of their location, should be required to effect abatements simultaneously, so that no single plant or group of plants would enjoy an advantage over competitors Such a program calls for federal participation

To anyone who has noted the increased demands of the public in recent years for the effective cleaning of streams and coastal waters, it must be apparent that the time is rapidly approaching when an intelligent and comprehensive plan for dealing with the problem must be evolved. If industry and government co-operate in finding a solution, it will be easier, less costly, and less disruptive than if a thoroughly aroused public, irked by delays and subterfuge, finally insists on immediate, drastic, and precipitate action.

Rubber Saves Trees

MODERN tree surgeons are learning more toward use of materials of a highly resistant nature which will give with the tree's motions, will not harm the tender growing cells by chafing, and will at the same time permit the growth of an even, natural roll or callousing of the cambium layer over the filling Rubber has been found to be the most satisfactory material to meet these exacting requirements. Of over 5000 cavities that have been filled with rubber, formed in special interlocking strips, not one has failed and all have healed rapidly. Consequently, the use of rubber is spreading



Fitting an end of a strip The concave upper and convex lower sides interlock all strips in a cavity. The "T" on the rear of the strip ties in with the cavity-filling compound



After a cavity is cleaned and dressed with tar, sections of the specially compounded rubber strips, cut to proper length, are wedged into the clean opening



Fitting a section of a more recently designed strip. On the rear face of this there is only a single channel to interlock with the filler. Rubber may, of course, be used in filling tree cavities in any weather, thus giving it a big advantage over other materials



After the strips are wedged in tightly, a motor-driven buffer rapidly takes away the slightly projecting edges of the strips and leaves a smooth, natural looking surface



A filled tree is sightly and in some cases its wounds are scarcely noticeable. Nature soon completes repairs with healthy growth

The special, new machine which forces melted, sterilized wax, by steam pressure, into the cavity back of the rubber dam. Rubber and wax effectively exclude water, bacteria, and fungus and let the tree heal



Section through a cavity showing how this process, developed by Goodrich research men and Van Yahres Tree Service, permits rolling growth of new wood over the cavity

THERE is no need for any remarkable machine, the brain-child of some science-fiction author, to enable us to peer into the fourth dimension.

But is there any fourth dimension into which to peer? Or, if there is, isn't time the fourth dimension, and how can one peer into time?

Time is sometimes treated mathematically as sometime like a fourth dimension, but time is "imaginary" in the mathematical sense of involving the square root of minus one. The fourth dimension which I am about to discuss is a fourth space dimension, exactly like the three—length, width, and height—with which we are all familiar, and standing at right angles to all three, just as each of them stands at right angles to the other two.

We need not agree as to whether or not such a fourth dimension actually exists, or even could exist. Being threedimensional creatures, we could not sense the existence of a fourth dimension, even if there were one. We are like the two-dimensional man of Dr. Edwin Abbott's story, "Flatland," who tailed to

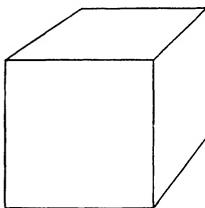


Figure 1 A cube in perspective

grasp the significance of "upward." But, by the use of the familiar principles of perspective, we can visualize exactly what hyperspace would look like, if there were such a thing as hyperspace

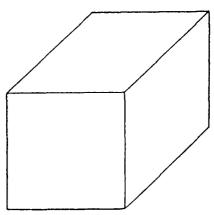
For, in much the same way by which perspective enables us to represent a cube on a sheet of paper, the same principles enable us to visualize the fourth dimension (if there is any) by means of three-dimensional figures.

The four-dimensional analogue of a cube is generally known as a "hypercube" or "tesseract." But the word "hypercube' includes objects of more than four dimensions, and so I prefer the word "tesseract," which applies specifically to a cube of only four dimensions. A five dimensional cube is called a "pentact." And so on.

Figure 1 shows the familiar two-dimensional picture of a cube. It clearly demonstrates how easy it is to give an accurate idea, in n-I dimensions, of what an object of n dimensions looks like

VISUALIZING

An Attempt to Peer Into the Fourth Dimension of Space by Constructing a Three-Dimensional Model or Analogy to be Used as a Taking-off Point



Ligure 2 Cube picture, isometric

There is another kind of perspective, known as "isometric," characterized by the fact that no distortion of lengths takes place. Figure 2 shows an isometric picture of a cube

By following the exact analogy of what we did to get Figure 2, we can make a three-dimensional model of a tesseract. Figure 3 is a sketch of such a model But this sketch, of course, involves using perspective twice in succession; it constitutes a two-dimensional picture of a three-dimensional model of a four-dimensional object—too far removed from the tesseract itself to convey a very clear idea of what a tesseract really looks like

We might just as well try to visualize a cube from a one dimensional representation of the cube. The two-dimensional

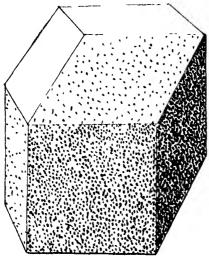


Figure 3: Model of a tesseract

picture of the cube (Figure 1 or Figure 2) gives us a pictry good idea of what a cube is like, but a one-dimensional representation (Figure 4) would be almost meaningless. Similarly, a three dimensional model of a tesseract would give us a very good idea of what a tesseract is like, whereas Figure 3 gives us no idea at all

So it is suggested that the reader huild himself a cardboard model, by making an enlarged copy of Figure 5, cutting it out with shears along the outside border, bending it on the lines, and then pasting it together by the flaps. For convenience in pasting, I have key-numbered each of the flaps, and have given corresponding numbers to the edges to which the flaps are to be pasted.

Now, to digress for a moment in order to discuss the number of points, lines, and so on, in a tesseract, a pentact, and others, let us start with no dimensions: that is, a point. The one-dimensional analogue of a point is a line segment,

Figure 4. Almost meaningless!

obtained by moving the point a short distance into the added dimension. This motion gives us two terminal points and one line.

The two-dimensional analogue is a square, obtained by moving the line into the added dimension, a distance equal to its length. This motion doubles the number of terminal points, and produces four margin lines. The reason for this last number is as follows. The original line is one, this line in its new position in the new dimension is one more, and each of the two ends of the original line traces a line by its moving.

THE three-dimensional analogue is a cube, obtained by moving the square into the added dimension, the same distance as in each of the former shifts. This motion doubles the number of corner points, thus producing eight. The number of lines equals twice the original number of points: 12 in all. The number of surfaces equals twice the original number of surfaces, plus the original number of surfaces, plus the original number of lines: six in all.

Before proceeding to the tesseract, let

Hyperspace

By RALPH MILNE FARLEY, M.A.

To many minds there is a strong fascination in the more uncommon, often bizarre aspects of mathematics, of which the geometry of hyperspace provides an example. From time to time such mathematical articles will be offered if the response to the present one indicates a sufficient volume of reader interest —The Eduor

us tabulate these results obtained thus far.

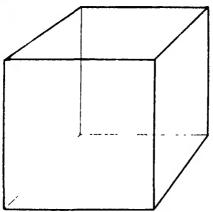
Object	Points	Lines	Squarec	Citte
Point	1			
Line	2	ì		
Square	1	1	1	
Cube	8	12	6	- 1

An inspection of the above table shows us that (for the reason given under our discussion of the square) each number in any row is equal to the sum of twice the number directly above it, plus once the number diagonally above it to the left. This consideration enables us to compute readily the number of elements of a tesseract and of a pentact, thus extending our table as follows.

Object	Counts .	Lines	Squares	Culis	I cont	
Cube	8	12	6	1		
Тевветас	1 16	32	24	8	3	
Pentact	32	80	80	40	10	1

By use of the same technique, this table can be extended indefinitely, to show the number of elements in hypercubes of higher order ¹

Let us now consider our pasteboard three-dimensional model of a tesseract Referring to Figure 2, we see that, in this pictorial representation of a cube, three of its six faces are invisible. They are within" (that is, behind) the three visi



Ligure 6 II a cube were transparent

ble faces Similarly, in the case of the cardboard model of the tesseract, 12 of its 24 faces are invisible, being "within" the 12 visible faces.

If, in Figure 2, we had represented a transparent cube (see Figure 6), then all six faces would have been visible. Similarly, if the reader will fasten 32 matches together with sealing-wax, to

'Algebraically expressed, the number of elements of order a in a hypercube of order b is 2^b b^i $a!(b-a)^i$. The sum of all the numbers in any row of the table is 3^b

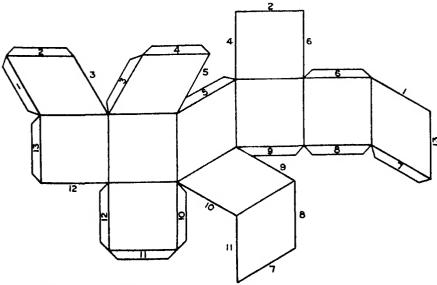


Figure 5. A reduced tesseract pattern. For convenience it may be enlarged

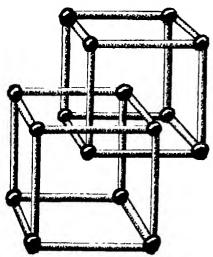


Figure 7 Building with matches

represent a projection of the 32 edges of a tesseract, he will be able to see all 24 faces of all eight cubes which go to make up this projection of a tesseract into three dimensional space.

To hitch these matches together, first form two cubes, with one corner interlocked, as shown in Figure 7. Then, using eight parallel matches set diagon

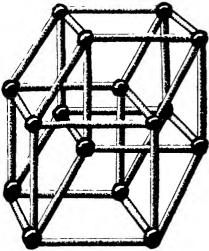


Figure 8: Contaming 32 matches

ally, run one of these eight matches from each corner of the first cube to the corresponding corner of the second cube, as shown in Figure 8.

As stated at the beginning of this article, I am here expressing no opinion as to whether a fourth space dimension does or does not exist. We three-dimensional humans are so three-dimension-conscious that we never can answer this question.

But the match-model of Figure 8 will enable us to visualize exactly what a four-dimensional cube would look like, if there were a fourth dimension and if we were permitted to peer into it.

Your Inferiority Complex—if you own one—is the subject of an article to appear in an early number.—The Editor

How Much Snow?

FAST winter, at 682 different locations in the Rockies and high Sierras, more than 30 000 exact measures ments of snow depth and water content were taken, in order to estimate how much water the mountain snowhelds would supply in the run-off during summer months. To make this survey cost more than \$100,000. On it was predi cated the expenditure, and saving, of nullions

While the science of surveying snow is still in its infancy, its extent and iniportance are increasing rapidly Ridiculed at first in the last few years it has taken on world-wide aspects. To grasp its significance in our western states, picture a series of snow-covered mountain ranges that by their streams make life possible in dry intervening valleys. Abundant snow means abundant water Abundant water means power, and cheap electricity. More important still, it means abundant crops. Dearth of snowfall in the mountains means dry river beds in August, machinery standing idle, thirsty cattle and dying plants.

In states where rainfall is fairly constant the year around, extensive snow surveys are for the most part still unknown But in states where no rain falls from spring until late autumn, streamflow is the measure of life and prosperity. During years of drought the stream-flow, even in the mountains, sometimes drops to less than a third of normal. In extremely wet years it rises to three times normal

Power companies build plants only where they can be assured of enough water, season after season, to turn their turbines. Western cities need to know, New Science of Snow Surveying . . . Quantity of Snow in the Mountains Determines Later Run-off Below ... Knowledge is Vital for Power Plants, Irrigation

By MYRON M. STEARNS and BLAINE STUBBLEFIELD

far in advance, whether or not the water supply for their great aqueducts will meet their demands Cattle men turn stock into valleys where they know grass will remain green and springs will not dry up Flood control and soil conservation districts alike need to know how much water they may expect. And even beyond that there are uses for snowknowledge for which few of us would even think how large the culverts should be under new highways across the Utah descris, how deep the water will be in navigable rivers like the Sacramento in California, how far upstream salt tidal waters will force their way, making the current unfit for irrigating delta orchards.

O make the snow survey, state fed-Letal, and private agencies join hands Some of the work is supervised by the United States Forest Service, some by the National Park Service, some by powcr companies. Some is done by cities, by nrigation districts, by utility districts, by private land and lumber companies Califorma, like several other western states, has a state bineau of water resources With a slender annual appropriation of \$15,000, the United States Bureau of Agricultural Engineering steps in and co-ordinates all the different

reports into a single survey for the enthe mountain area from Mexico to the Canadian border and, with the co-operation of Canadian authorities, even beyoud the boundary

In April, forecasts based on the snow surveys go on the main news-service wires Newspapers print them in full They are carried in radio broadcasts Ranchers, hotel keepers, river men, orchardists, western salesmen of farm machinery, automobiles, and almost everything clsc, store keepers, dwellers along the great sand rivers of the



Evaporation pans used in snow surveying. Hanging. Tree pan, ice pan, and snow pan, Below. A core cutter for filling the snow pan, and a false bottom to raise the contained snow

above the level of the melted snow

Southwest-all take note and build or modify their plans accordingly.

To determine the stream flow of the great Colorado River into Boulder Dam snow surveys cover an area of more than 100 000 square nules along 330 miles of mountain crests.

In 1931 the residents of the Humboldt Basin were told that only 51 percent of the normal snowfall had been found at the source of their streams and that, owing to lack of spring rainfall, dry river beds and the like, they could expect barely 10 percent of the normal run-off:



Mt Rose Observatory, on the summit (10,800 feet) of Mt. Rose, in Nevada, where, in 1905, Prof J. E. Church established the first western snow surveying camp

no use of planting any late-maturing crops in the Humboldt Basin that year. (The Humboldt River rises in the mountains of Nevada, and was described by Mark Twain as being so small that the Forty-niners could run and jump across it for exercise, and then drink it dry to cool off. He might have added that in years of flood they could have sailed over the entire valley for a thousand miles.)

In 1934 the Utah Co-operative Snow Surveys forecast a severe drought in the Utah area. With this warning thus provided in time, diversion ditches were hastily dug to bring water from Bear Lake, on the Utah-Idaho border, to forestall a part of the shortage. It is esti-



The height of the snow sampler in the man's hands shows snow depth

mated that, through the timely snow surveys, a saving of nearly \$4,000,000 was effected. This is the first time in history that a drought conference was called before the drought.

The leading snow scientist in this country is Dr. J. E. Church, of the University of Nevada, oddly enough a professor of classics, although endowed with the flaming scientific spirit of an Audubon, That Dr. Church should be teaching literature and art, instead of science, is one of Fate's ironies. Enrolled as a youth at the University of Michigan, he took the classical course because he was told it was the hardest. Upon graduation, he was offered a chance to teach Latin at the young University of Nevada He has remained there, honored and contented, ever since. But he was interested chiefly in geology, in the beauty of the mighty Sierras, in exploration, in snow.

In the middle of the winter of 1894, on a dare, he climbed to the summit of Mt. Rose, south of Reno, 10.800 feet high. He attempted a winter ascent of Mt. Whitney, highest peak in California and the United States, only to be foiled when near the summit by a layer of soft snow above a harder crust In 1904 the



All photocraphs courses The American Grogosphical Society

At a height of 9000 feet at Contact Pass. A refuge hut and snow survey station
made of sand bags. A wall of rocks on the windward side prevents erosion.

problem of the value of forests for conserving snow was being bitterly debated Upon his return from Mt. Whitney, Dr Church, because of his knowledge of conditions in the Sierras, volunteered to procure data. Under the vision of Piesident Joseph E. Stubbs of the University, and the enthusiasm of Samuel B. Doten, later Director of the Nevada Agricultural Experiment Station, which undertook the task, the funds provided by the newly created Federal Adams Act for research were applied to the problem. Mt. Rose Weather Observatory was born, There was little besides hardship in the undertaking, but it added to his snow-knowledge, which most people still thought utterly uscless.

Then there came a winter of deep snows-1906 1907 Lake Tahoc, which hes in the Sierras between Reno and the California plains, rose far above its normal level Cabins along the shore were flooded, and hoat landings were carried away Summer cottagers blamed the power company which had erected a shallow dam above the lake's narrow outlet. When other heavy snows impended they threatened to dynamite it. The power company then called in Professor Church to aid them in guessing how much water would descend into the lake the following spring-and American snow surveying, for practical purposes, was born.

THE depth of mountain snows has been of interest for thousands of years, but it was not until the late inneties that Russian scientists began melting snow to see how much water it contained. Not its depth but its weight determines what water will run off when snow melts. In this country, in 1900, Charles A. Mixer tried melting samples in Maine. He wanted to forecast the run-off of the Androscoggin River and estimate how much of a stream there would be in the spring to float out logs. Only a short time later Robert E. Horton in New York actually drove a tube into

the snow and weighed the snow core.

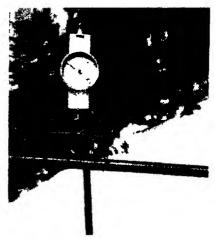
But early estimates based on depth had not been accurate enough. Dr Church devised a measuring tube known as the "Mt Rose snow sampler" It consists of a long pipe, slotted along one side so that you can look into it and poke into it. The depth of snow is measured by a scale on the tube. Then, to determine the all important water content, the core of snow that has been pushed up inside the tube in the measuring process is carefully weighed. The Mt. Rose balance records the net water inches in the snow directly. Thus it is possible to tell how much water there is in a snow field.

Still the job of estimating the total water content of a whole watershed was too complicated. As a short-cut, Dr Church proposed finding out first what the average snowfall in each region was, by comparing records of different years. After that, all they had to do was find out each spring just how much more, or less, than the average amount of snow had fallen during the month. Half as much snow as usual meant that half as much water would run off next summer. The system of measuring snow only in terms of the average snowfall has now also been universally adopted.

Actually, of course, many other factors enter in. For example, the condition of the mountain soil on which the first snow falls—whether dry and porous or frozen after early rains—makes a great difference in the run-off. A succession of clear, windy days during the period of inn-off may mean some loss of snowwater through evaporation. A heavy thaw in April, or a cold, late spring, may change the order of run-off materially.

One year Dr. Church's early prophecies were nearly 50 percent wrong The expected high water did not occur. To Dr. Church, nature had plainly interfered and he prayed that she would repeat the trick. Lack of precipitation during run-off was soon found to be the cause. But the damage was already done.

An irate irrigation project manager became hostile, and federal funds were withdrawn. Had it not been for Major Paul M. Norboe, of the California State Engineering Department, who had enough vision to foresee how valuable snow-surveying would eventually become, much of the work already done would have gone for nothing. As it was, Major Norboe made an offer from the



A Mt. Rose snow sampler, slotted pipe held horizontally in its balance

State of California to buy all the equipment being abandoned, and continue the experiments. Dr. Church accepted the offer with a thankful enthusiasm such as only a scientist can feel. He got Nevada to combine in a limited way with California in support of the snow-survey continuation, and later on, when the value of the work became more and more apparent, the Experiment Station came into the picture again.

The men who make the actual surveys are foresters, water-men, mountaineers. There are more than a thousand of them They have to be tough. Courses are located at altitudes ranging from 6000 to more than 11,000 feet. Chmbing the snow peaks of the Alps, in summer, for fun, is hazardous enough; climbing over the snow-fields of our western mountains, in the dead of winter, to make hundreds of careful, scientific measurements, perhaps with the thermometer far below zero, is more dangerous still.

Although the survey-men regard risks and hardship as all in the day's work, they are never allowed to make their trips alone for, without a companion, a slip might mean even their bones could not be found until spring or summer Mostly they work in pairs or, on longer journeys, in threes. They are ordered to maintain contact with each other at all times. Usually they travel on skis or snowshoes over snows that lie 10, 12, sometimes 20 feet deep. In 1917 Mt. Rainiei had more than 27 feet. A record depth was reported in 1911 at Blue Lakes, source of the Mokelumma River: 36 feet, 2 inches.

Snow banks 30 to 50 feet deep are not

uncommon, and in the southern Sierras one mountaineer, in summer, saw ax marks on tree-trunks 35 feet above the ground, where a trapper had blazed his winter trail over drifted snow. In Oregon one drift was found to be 110 feet deep

Winter temperatures on the mountains are formidable. When gale-driven they wither the flesh. Near the borders of Wyoming, Idaho, and Utah, 50 degrees below zero is often encountered. Sixtytwo below was noted in Yellowstone Park. In the Ruby and Wasatch Mountains of Nevada and Utah, swings of 70 degrees in a single day are fairly frequent: from 30 above zero, barely freez ing, at noon, to 40 below at night Climbing steep slopes over deep snow, with heavy packs, the men sweat even when the mercury is below zero; then, stopping to rest, they have to be careful not to freeze their hands or feet,

Shelter cabins are built for the surveyors high on the ranges. They are strong, in order to carry the great weight of snow that may pin them down. One snow surveyor in Oregon carefully measured the snow on the roof of one small cabin in the Cascades, and found it to weigh almost 13½ tons.

SNOWED-UP cabins are sometimes hard to find. To help locate them, shovels are tied high in nearby trees. Chimneys through which a man can descend are built to save the work of digging down to them. In some cabins, to make sure they can be found, a pole is left sticking up even higher than the chimney.

Before a survey trip is ordered, weather maps are studied as carefully as for a transatlantic flight. When conditions seem favorable the men are ordered out. They go as far as they can by auto, and sometimes a few miles faither on horse-back. Then the real climb begins on foot Packs are kept as light as possible. There is a snow sampler, a tube 21 feet long. For ease in carrying, it is made in three-foot sections that can be screwed together. Care has to be taken not to touch the tube with a bare, moist hand when the temperature is very low; the skin would freeze to it instantly.

Surveyors sometimes travel at night to avoid the danger of slides. At Wagon Wheel Gap, Colorado, one surveyor was killed in a slide while his companions were marking snow courses.

The snow courses are from half a mile to three miles long, usually in the form of a letter X. Measurements are taken each year at exact distances, from perhaps 20 to as much as 100 feet apart, at points previously determined, with a total of sometimes 100 samplings for an entire course. Each course provided with a shelter cabin means, as a rule, a three-day trip—one day to get in, one day for snow measurements, and a day to get out. Cabins are stocked with a variety

of dried foods, in tin-lined bins to keep out rats. "Freezing," say the instructions, "has no particularly detrimental effect upon any of the above foods"—the list runs from black tea to canned grape fruit—"during the first year."

So important has snow-surveying now become that an International Commission of Snow was formed in 1933, under the presidency of Dr. Church, with more than 170 prominent scientists representing nearly every country in the northern hemisphere and a few from below the equator. The first meeting was held in Edinburgh in 1936, and Dr. Church was re-elected president. Scientific papers were offered that, in printed form, total more than 800 pages. The second meeting will be held this year in Washington

Sweden, first European country to adopt the Mount Rose system of snow measurement and surveying, is interested in forecasting stream-flow for running logs to saw-mills. Southern Australia surveys snow to forecast stream flow as a source of power. Switzerland is studying the effect of snow on the formation and movement of avalanche and glaciers. England wants to know more about the effect of snow on the formation of incipient ice-caps. Denmark's



A snow pan protected from falling snow by a special covering or hood

problem is England's in reverse: Danish soil is too sandy and dry, so how can further erosion of soil and snow be checked? Finland is scrutinizing snow-surveys from three different angles: stream-flow for water-power, the relationship between snow and frozen soil, its relationship with frozen harbors. Esthonia, Latvia, Lithuania, and Russia are all interested in the effect of frost and ice on the winter flow of their streams and the choking of intakes. The tivers of all those countries are capable of producing power—but they have to be coaxed.

Our own Department of Agriculture estimates that, through snow surveys and the development of all possible water conservation, the 18,000,000 irrigated acres of our western states can eventually be increased to 50,000,000 acres, an area as large as England.

Now Helium Saves Lives

A Mixture of Helium with Oxygen is Beginning to Be Used by Physicians to Tide Respiratory Cripple Cases, Such as Chronic Asthmatics, Over Their Crises

By NORMAN GOLDSMITH, M.D.

An infant lies gasping.
Something is blocking his air passages. With each effort to breathe, the spaces on his chest between the little ribs become deeply marked. He keeps growing more and more tired. Soon he will stop trying entiely. If there were only some way to lessen the work those tiny lungs must do.

Since 1934, there has been a way—helium

Most people think of helium as an mert gas, discovered in the Sun's spec trum before it was found on earth, whose sole use is for filling dirigibles because, even though heavier than hydrogen, it is non-inflain mable and the ghosts of the *Hindenburg* still haunt. But there is another use

Basically, air consists of 21 percent oxygen and 79 percent nitrogen. Helium weighs only one seventh as much as nitrogen. Hence a mixture of 21 percent oxygen and 79 percent helium possesses certain interesting physical qualities. Thus it has only one third the density of an and, more important, requires only about half the effort to pass through a

narrow orifice.

Now what has this to do with a respiratory cripple like the infant referred to or a patient with chronic asthma? It means simply that if overtaxed lungs are allowed to breathe a helium-oxygen mixture, they need do only about half the work as if they were breathing ordinary air. To a well person this may not mean much. Put him in such an atmosphere and his voice will sound very high and an ordinary whistle will reach a lofty pitch, but that is all. For a patient with respiratory struggle, however, anything which takes some of the load away may well mean the difference between life and death.

It all started back in 1923, when Charles Cooke received a patent for the use of helium with oxygen for divers,



Courtess Oxygen Equipment Minufacturing Company
Apparatuse—cylinder, rebreather, tubes, and tent covering
patient's head—for supplying the oxygen-helium mixture

based on the lesser possibilities of this mixture causing "the bends." Then, in 1926, Sayers and Yant found that animals could be decompressed in a helium atmosphere in one third the time necessary for an

The major contribution, however, toward the treatment of patients was made in 1934 by Dr. Alvan Barach of Columbia University. To prove that the gas was absolutely innocuous he kept mice in a helium oxygen atmosphere for two months. The animals thrived and came out of their artificial environment perfectly well. Following this, he turned his attention to humans. Patients have been in such an atmosphere as long as four and a half days and, to prove that there were no harmful effects, he has had professional singers switch from one medium to the other without ill effect.

In what conditions is the heliumoxygen mixture of use? Asthma, certain anesthesia difficulties, any obstruction of the air passages, and asphyxia of the newborn If we take the infant who was struggling so pitifully, with his rib spaces deeply accented, and place him in the helium atmosphere, his chest wall smooths out and he breathes comfortably. Or take the old man wheezing with chronic asthma, his lung tissues so fatigued that they react no longer to adrenalin. Place him in the new atmosphere and he has time literally to catch his breath. His apprehension diminishes

and he may be able to sleep. Such treatment may be continuous for from one to five days or intermittent—a few hours each day. In grave cases, such measures have proved life-saving. Also, the tissues again become able to react to adrenalin and the patient acquires a new lease on life

Now helium-oxygen is not a cure. It is merely an aid in the same sense that an elevator is an aid to a person with a bad heart or a cane to one with a defective leg. The mixture saves work and, when the patient comes out, the temporary rest may give him enough strength to carry on himself. Further attacks for a while may be less frequent.

How much does belium cost? All belium is owned

by the United States government but special dispensations have been made for its use by practising physicians, an interesting contrast to the government's refusal to sell the gas to Germany for a possible war use. The gas is sold in cylinders which contain about 200 cubic feet, an ample quantity for one patient for 24 hours. The charge for this is between \$10 and \$14, depending on freight distances.

Distribution is through the same channels as oxygen, there being approximately 50 oxygen supply companies in the New York area alone. The giving of helium is more difficult than that of oxygen since it is necessary to maintain the actual concentrations of the two gases without any inward leakage by nitrogen. This is obtained by a special hood tent which fits around the neck. Special accessories permit considerable salvage for rebreathing, as shown in the illustration on this page.

Already the helium-oxygen mixture has been employed, in addition to New York, in Washington, San Francisco, Boston, Cincinnati, and at the Mayo Clinic

Biskupin

By J. KOSTREWSKI

THE village of Biskupin is situated in the northern part of Great Poland, 65 miles to the northeast of Poznań and to the southwest of Toruń, the capital of Polish Pomerania. Nowadays it is famous, not only in Poland but throughout the world, for the remarkable discoveries made in its vicinity by the Poznań University Archeological Expedition, Excavations have been carried on for four years, and have revealed the ground plan of a prehistoric stronghold which was built on a peninsula jutting into the lake of Biskupin, on the surface of a former peat bog, in the Early Iron Age, between 700 and 400 B . . but abandoned in consequence of its inundation by the waters of the lake. The site was covered with a thick deposit of sand and mud, which protected the remains against atmospheric influences, while the dampness of the ground caused the preservation in excellent condition of the lower portions of the huts and the wooden defensive works, as well as the roads and breakwaters.

During the Bronze and the Early Iron Ages a great part of western and central Poland as well as eastern Germany was inhabited by an agricultural people known as the Urnfield people, of Lusatian type, and who are considered by nearly all Polish prehistorians as ancient Slavonic. Being threatened with invasion by the cist-grave and face-urn people of Pomerania, who were probably of ancient Baltic stock, they took refuge in forts constructed of wood and earth placed in inaccessible spots, for the most part on islands and peninsulas. Nothing but the necessity of defense can have induced the prehistoric inhabitants of the neighborhood of the present Biskupin to establish themselves on the damp and peaty peninsula extending into the lake, which was both unhealthy and unsuitable for building. This peninsula, surrounded on three sides by the lake and cut off on the land side by a broad strip of marshy ground, was further fortified, as the excavations hitherto made have indicated, by a wooden rampart filled with beaten earth, which was carried round the whole site. This rampart was built three times, and each time nearer to the center of the peninsula. Only small fragments of the earliest and northernmost have survived; it was clearly destroyed by water. Later the area enclosed within ramparts was re-From Antiquity

duced and the first breakwater constructed, and within its shelter a second rampart was raised. When this latter was partially destroyed by fire, it was replaced throughout a considerable length by a third, rather narrower, wooden rampart eight feet wide, running parallel inside and south of it, which however is not continuous, but is interrupted by a row of huts, because the old rampart was well preserved at this point. It was constructed of beams, overlapping and placed crosswise, chamfered at the intersections for security, and supported by piles driven in vertically on the inner side. The result was two or three rows of caisson-like chests, which were then filled with stamped earth. Considerable remains of the middle and latest rampart, in places as much as three feet high, have been laid bare in the north and east of the peninsula, while on the south the rest of the rampart, which once prevented access on the land side, can even now be clearly identified.

ALONG the middle rampart a row of piles were driven in obliquely to protect it against the undermining action of the waves. Farther toward the lake is a double row of similar piles, constituting the oldest actual breakwater, and beyond it again another, consisting of seven or eight rows of great piles driven obliquely into the edge of the lake and strengthened by the imposition of

horizontal beams. The innermost of these breakwaters is considerably lower-perhaps two and a half feet-than the second. Obviously, then, the original low breakwater had to be replaced by a new one, higher and a little farther toward the lake, owing to the rise in the water level. Access to the rampart was facilitated by a circular street running along the inner side of it, and three great piles, driven into the edge of this road at a point where a sharp turn rendered it difficult to build a house, seem to have supported a kind of gangway leading on to the top. Within the latest rampart were found heaps of stones, apparently laid there to be hurled against an advancing

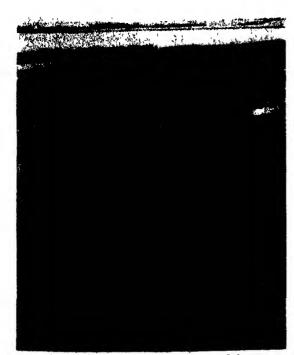
The area thus fortified was occupied by a populous settlement, composed of from 80 to 100 huts, built on a layer of birch fascines resting on the surface of the peat-bog. The ground plan was laid out in a masterly fashion which would have done no discredit to a modern town planner. In the area so far excavated eight perfectly parallel roads or lanes have been laid bare, running from west to east and connected by an outer one, running round in a half circle within the rampart. These lanes were of corduroy construction, that is to say, made of thick oak logs. On either side of each street were rows of wooden huts standing end to end and actually touching. Indeed there was frequently only a single common end wall. The huts were about ten yards square, and their doors, sometimes eight feet across, were always on the south side, evidently serving to let in light. These huts usually contained two rooms; a main one with the hearth and a vestibule, six or eight feet broad, which took up the whole front. Sometimes, the main space was divided into two compartments; one, smaller than the other, having perhaps served for the accommo-



Remains of wooden ramparts at Biskupin, surrounded by the expedition's dyke. Remnants of the earliest ramparts show at right—successive once to the left

dation of cattle or as a sleeping-room. To the right of the entrance, in the main room, was the round (rarely square) hearth, most frequently made of stones and as much as six feet in diameter, but occasionally of nothing but clay. The floors were composed of wooden beams resting on fascines of crossed or sometimes interwoven birch sticks and branches, and were covered with a layer of clay to diminish the danger of fire. The stone hearths themselves were also overlaid with clay, which preserved them from being blackened or split by the heat.

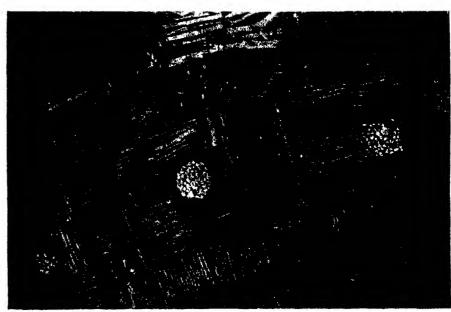
All the houses are built on the same plan. At the corners are placed round posts of pine, in each of which are cut two vertical grooves, running the whole length of the post, an angle of 90 degrees separating the one from the other. Between these corner posts are flat ones, usually of oak, with two vertical grooves. Into these grooves are fitted, one upon another, beams or rough-hewn planks with flattened ends. In some of the better preserved huts as many as three still remain in position. The door posts were also grooved on the outsides, their door sides being smooth. At the bottom all thèse posts were supported by cross pieces running through them and pro-



At left center, entrance to a hut; at left top, some of the ramparts and, at the extreme left, part of the circum-peninsular road or street

jecting on either side, to prevent them sinking in the peat-bog. This method of building is still employed in various parts of Poland, and even at Biskupin itself there is a peasant's cottage constructed on exactly the same principle, so it may be that an ancient building tradition has been preserved for 2500 years. As the upper parts of the huts have been destroyed, it would have

The Excavation of an Early Iron Age Village in Eastern Europe Brings to Light Artifacts Showing the Daily Life of a People of about 2500 Years Ago



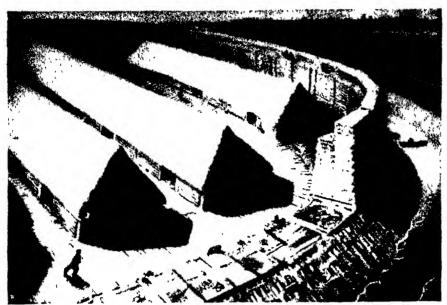
Vertical view of two huts comprising three rooms; also the middle rampart

been impossible to estimate the height had not two or three posts from destroyed ones been preserved by being used a second time in the floors or the lower parts of the walls. Some of these are 13 feet long, so that, allowing for three feet in the bog, the height of the walls was probably ten feet.

A number of observations go to show that the huts excavated at Biskupin are not all of one date. Huts were frequently destroyed by fire, and new ones built on the same site, in which case remains of the old ones were so far as possible incorporated in the new. In some, therefore, we find two door posts side by side, or two corner posts, or flat wall beams from two separate huts that were built in succession on the same site; indeed there are occasionally remains of three huts built one after the

other on the same site at different periods. Two floors and two hearths, one above the other, are found comparatively frequently, separated by a layer of soil 12 to 20 inches thick, and there are a few examples, especially in the lower or northerly portion of the area, of two or three levels in a street. In either case the lower level, alike in hut and street, is solidly constructed of thick

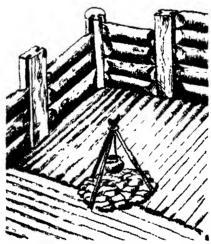
oak trunks while the upper is carelessly and hastily composed of thin birch poles. These later road and floor surfaces are evidently to be connected with some great flood which inundated the settlement and compelled the inhabitants to raise its level. When this settlement was founded the level of the lake must have been considerably lower than it is today, even though it was markedly lowered a few years ago by the deepening of the Gasawka stream, which runs through it. Evidence of this is found in the fact that the hearths of many huts which have been excavated are now below the surface of the lake. During the course of the settlement's existence, however, there must have been a marked increase in the volume of water in the lake, due not only to local causes such as the silting of the bed of the Gasawka, but also to a general increase of rainfall; for the researches of paleobotanists show that in the Early Iron Age the climate of Poland, in common with that of a considerable part of Europe, was steadily becoming damper and colder. Our excavations confirm this for the northern part of Poland. The influx of water due to the increased rainfall seems finally to have become so great that the inhabitants abandoned the flooded site. But that which was a catastrophe for them has turned out a blessing for archeology. For, although everything which was above water level has been completely destroyed, the foundations and lower parts of the huts and the other constructions, covered with



A reconstruction of the northern part of the village, as drawn by W. Boratvuski

water and earth, have been preserved almost as they were left 2300 years ago

This protective layer of sand and mud has also preserved a large number of tools, ornaments, and weapons used by the ancient inhabitants, and even a few pieces of furniture such as the lower part of a family plank hed discovered in one of the huts. Pottery especially is very well represented Besides coarse ware there are some very beautiful, richly ornamented specimens; for example, incised vessels encrusted with white material or painted with red ochre, lumps of which have been found on the site. Two vessels are decorated with very conventional figure-drawings: a few riders, and a hunting scene with several horsemen and two stags. There are numerous bronze objects, 40 pins, some of them swan necked, a few bracelets and small rings, needles, fishhooks, a razor, tweezers, double cone-shaped beads, buttons, and many other objects. Iron socketed celts, sickles, awls tone of them still in its bone handle), needles, a bridle bit and pins have been found; as well as horn and hone awls, mattocks, large hammers with square holes for the handles, socketed spearheads, tanged arrow heads with barbs, smoothing tools, and so on Wooden implements include swirling sticks, pestles, two kneading troughs, pine bark floats for fishing nets The most interesting wooden objects are a primitive plough, a solid wagon wheel of Mercurago type, made of a single block of wood, with a square hole for the axle and two semicircular openings cut out on either side, strengthened by two strips let into the wood across the grain, an oak axle from a cart, and three wooden gratings, one of them lined with wicker, which were doubtless used as hut doors. Other finds include blue glass beads, most probably imported from Egypt, various stone implements such as pentagonal celts, circular and triangu-



Showing the original method of construction of the huts at Biskupin

lar tools the purpose of which is unknown, but which may have been used to smooth carthenware vessels or to prepare hides, querns and grindstones, clay implements for spinning and weaving, whorls and loom weights, and clay toys. The numerous carbonized grains of corn, wheat, barley, millet, pea, and vetch which have been found, and fibers of flax, point to the agricultural character of the population. The bones of domestic animals found show the importance attached to cattle breeding. Wild creatures are represented mostly by the stag and the hare, more rarely by the bear, and occasionally by the wild boar, the wolf, the fox, the beaver, the wild duck, and the hawk. Fish bones occur but rarely. Other occupations of the people are clearly illustrated by the discovery of clay molds for casting necklaces, pins, and the like. They are all of the socalled cire-perdue type, that is to say the clay was plastered around the wax model, and, after casting, the mold had to be broken in order to get at the object. Such models, for this process, have not hither-

to been found elsewhere in Poland. The excavations at Biskupin have given us for the first time a conception of the appearance of a complete prehistoric Polish settlement, and have thrown new light on the material and social culture of the Urnfield people of the Lusatian culture. Only a well-disciplined body of men under energetic leadership could establish such a settlement and build it according to a unified and wellthought-out plan. It has sometimes been supposed that the Lusatian culture disappeared as the result of over-refinement and consequent decadence; but the discoveries at Biskupin give us a very different picture. The frequent occurrence of horn and bone implements on a site dating from a period of the highest development of the Lusatian culture, when bronze was beginning to be superseded by iron, offers a perfect analogy with the frequent use of horn and bone implements by the early historic Slavs-between A.D. 600 and 1000-who also raised similar strongholds and showed a similar tendency to settle on low-lying ground exposed to mundation. The most striking fact is that huts of identical construction are in use today over the whole area once occupied by the Lusatian culture, especially in Poland There are some, indeed, quite close to our site, at Godawy, on the east bank of the lake of Biskupin and at Biskupin itself. A similar hut, dating from the late Middle Ages, was excavated in 1935 at Keynia in the district of Szubin, and another dating from the 17th or 18th Century, at Ostrowo near Gebice in the district of Mogilno, and it may be therefore supposed that the type has existed in Poland continuously from the Early Iron Age down to the present day, it this is true it supplies one more proof of the Slavonic origin of Lusatian culture.

the site covers over six acres, of which only one third has so far been excavated. The best preserved portion, it is hoped, will be properly protected and kept as an object lesson for future gencrations. The archeological expedition hves on the spot in a camp of its own, containing a workshop, a dark room for photography, rooms for drawing, and so on. The whole site laid bare is mapped on a scale of 1:10 and several hundred photographs have been taken from ladders and from a balloon. The expedition has reconstructed two huts on the original plan, one of which serves as a museum, where the most interesting finds are exhibited.

Coming soon: The inside story of tele-vision as it will be presented to the American public in scheduled broadcasts to start this spring.—The Editor.

FACTORY 'MAGIC'

Ingenious Factory Process Solves Old Problem . . . Lower Cost . . . Transformer is Significant

() basic change has occurred in the design of the transformer, inert device for increasing or decreasing voltage of alternating current circuits, for more than 50 years Back in 1886, at Great Barrington, Massachusetts, Wilham Stanley developed and put into first practical use a transformer which, except for certain refinements, is the same in construction and principle as those in use

Now, however, a transformer developed by the General Electric Company, embodying an entirely new construction principle, has been placed on the market Although the operating advantages of the new type transformer, as well as its lower production cost, are economically significant, the manner in which the device is made is the more intriguing

The transformer is known as a "woundcore" type and embodies the solution to a design problem that has stumped the best engineers in the field for years. Its method of construction savors of the magician's stunt of linking together two scamless (1) steel rings and, like the secret to most tricks of legerdemain, is unbelievably simple.

Unlike old-type construction, the two sides of the wound-core's oval-shaped primary and secondary coils are each encircled by a core consisting of a tightly compressed, ribbon-like winding of thin, silicon-content steel. Unless closely inspected, the core and coil assembly might give the impression that two close fitting non rings have been miraculously interlinked with the oval coil assembly.

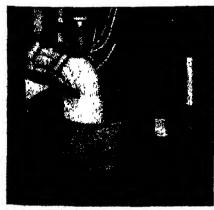
Actually, the steel cores are spirally wound about the copper coils by a specially developed machine which accomplishes the feat efficiently in a matter of a few minutes, as compared with the appreciably longer time required to hand-assemble the L-shaped steel punch-



window and loosely around post



End of strip threaded through coil



Process begins with pre-wound

metal strip core on revolving post

All of strip is unwound from post and is loose loop through window



Post retracted, the inner end of core strip is pulled in around coil

ings regarded as most efficient for the core construction of old-type transformers.

This accomplishment of winding the cores about the coils seems like a process that should present no great difficulty, and it wouldn't-except for the fact that the pre-wound shape of the core must be retained throughout the process. The outer turn of the core in its pre-wound form must be the outer turn of the core after it has been wound on the coils; and the inner turn must likewise remain the inner turn after the winding process is completed. This precaution is necessary because the spiral cores have been "set" in their pre-wound shape by carefully controlled annealing operations to retain the superior magnetic qualities in the steel. If the form of the core is too greatly disturbed in the winding process, small elastic stresses are caused and may increase the electric losses in the core steel by as much as 15 percent. Reversing the order of the turns might increase these losses as much as 25 percent!

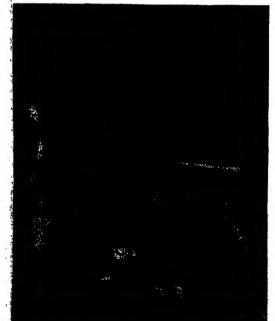
In the winding process, the pre-wound core is placed on a post adjacent to the coil assembly on the special machine Then the outer turn of the spiral core is passed through the "window" formed by the coil winding, brought around in a fairly large loop, and tack-welded to the next underlying strip of the roll By means of a series of revolving rollers, both the core and the large loop which has been formed by its outside turn are rotated. In this way the strip is unwound from the post and simultaneously rewound about the coil in its original form. The same operation is repeated on the other leg of the winding, and presto!the transformer assembly has assumed its misleading semblance of the linked rings of the magician



Outside rollers now roll the strip into a tight spiral around the coil

Proreign substances are removed from the crude rubber that will eventually become part of one of your automobile tires. In this machine the crude rubber passes through close-set rollers which chew the rubber and expose many surfaces for cleaning by a spray of water

4. Cotton now enters the picture. From it is made the cord which, in the illustration below, is being covered with rubber, each individual strand receiving its coating. Thus cord and rubber are merged to form the tire fabric. This type of construction is considered to be an important safeguard against tire deterioration through heat generated when the tire is in use



Rubber to Cotton

Rubber Thoroughly Cleaned . . . Ingredients Mixed . . . Cotton Cords Individually Coated With Rubber . . . Wire Beads . . . Treads Extruded in Slabs

By A. P. PECK

2 Below: The cleaned naw rubber is next worked into a plastic condition, after which it is combined with other materials, necessary to tire wearing qualities, in a machine such as that shown





Among the basic machines in the tire manufacturing industry is the rubber mill shown above. Here the mixture made in the machine shown at the left is passed between rollers so that the raw rubber and the added ingredients are compounded thoroughly. If this is not carefully done, mixing will be incomplete and the finished tires will not be wholly satisfactory

5 Sheets of tire fabric, formed of rubber impregnated cords, are cut to specified widths and angles as shown below. Practically all fabric now used in tire construction is cut on the bias on machines such as this to afford strength and flexibility, and hence greater satisfaction and higher road safety for the ultimate consumer—the motorist



TO TIRES



6 The head or edge of the tire is formed of woven copper wire, incased in a sheath of rubber and fabric. There are approximately 137 feet of this wire in the head used in an average size modern passenger car tire

8 Right A skilled workman in one of the plants of the B. F. Goodrich Company is assembling the various parts of a tire built by the "drum" process. The layers of cord are rolled smooth and the beads with their re-inforcing strips are tied into the curcuss. After breaker strips, cushion, and tread are applied, the drum is collapsed and the uncured tire is removed

Right: Preparing the strip of rubber which eventually will become the tread of a finished tire, bearing the distinguishing design of its manufacturer. Here the rubber batch is placed in the machine and extruded as a slab of rubber of the desired width. The tread is then ready for application to the completed tire body





Delow: The forming chumber where the tires built by the drum method are shaped. The casing, as it comes from the assembling drum (see 8, above), is placed in this chamber and a water bag inserted by means of a ram. Pressure built up in this bag forces the tire into the circular shape in which it will be vulcanized



10 Below: The shaped but uncured tires are here placed in steel molds where the tread design will be impressed. Still in these molds, the tire is vulcanized by steam and hot water



11 Below: Finished tires pass before a group of inspectors whose sharp eyes detect any minor imperfections that might injure the serviceability of the tire





MONTHLY DIGEST

INVISIBLE GLASS

CLARE from reflected light, which makes it difficult to see pictures framed under glass at certain angles, has been removed by a new process developed in General Electric's research laboratory by Dr. Katharine B Blodgett By applying thin chemical films to the surface of



Dr. Blodgett demonstrating how the anti-glare surface is put on glass

glass, Dr. Blodgett has been able to nullify or neutralize reflected light rays with the result that pictures framed with glass so treated appear as though there was no glass at all, regardless of the angle of view. The same is true with clock faces, show cases, display windows, in fact, any place where glare is caused by light reflections on glass.

The refractive index of any type glass is easily determined. This known, the process consists of huilding or attaching to the glass a very thin transparent film of about four milliontus of an inch, or exactly one quarter wavelength of light, in thickness. As light falls upon the film, rays are reflected from both the upper and lower surfaces. With the film exactly one quarter wavelength in thickness, those rays coming from the outer or upper surface are equal in intensity and opposite in phase to those rays reflected from the lower surface, and counteract one another; thus no light is reflected.

"The process is still in a laboratory

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN

In charge, Daniel Guggenheim School of Aeronautics, New York University

D. H. KILLEFFER Chemical Engineer

stage," Dr Blodgett explained "At present it has not reached such a stage that it can be offered the public However, we are hopeful that we may soon do so.

"Glass is treated by dipping it into a tank of liquid, on the surface of which is a film of insoluble soap but one molecule thick. As the glass is pushed down one layer of the film becomes attached and as it is pulled up another is applied. Thus



The clear part of this framed portrait is covered with the new invisible glass, the rest with ordinary glass to show the difference

cach immersion adds two layers of the film, each but one molecule thick. The dippings are continued until we have built up about 44 layers which form a thickness of one quarter wavelength, or about four millionths of an inch. We can measure or determine the exact thickness of the film at any time, although it may be thinner

than any substance we know of today, by an optical process

"The non-glare treatment of glass also promises to have a wide-spread application in the field of camera, telescope, and all other type lenses," Dr. Blodgett pointed "It is commonly known that reflection from the surface of any lens causes from 4 to 5 percent loss in the light transmitted Since this is true to both front and back surfaces, there is a light loss of at least 8 percent in each lens With some of the better type cameras, using three or four lenses, the loss of light reaching the plate or negative is 25 to 35 percent. With telescopes and submarine periscopes, where a larger number of lenses and prisms are used, the light loss is still greater. In some periscopes it is as much as 75 percent.

"With the exception of the slight loss by absorption in the glass itself, the film-treated lenses would transmit 100 percent of the light. With an actual test in the laboratory, a piece of glass was treated and by doing so we increased the light transmission from 92 percent to 992

WELDED METAL SCULPTURE

A WELDER, and a good one, is F. F. Nichols of David City, Nebraska. During the summer he has little time for hobbies but in the winter months he takes a hand in some unusual creative work of his own.

No soap sculpture or basement workshop



Figures created by welding

carpentry for him. Turning away from repairing castings of massive proportions, Mr. Nichols takes up his oxy-acetylene welding blowpipe, some steel welding rods and some bronze ones, a few additional light sheets of steel, and sets to work fashioning small metal figures depicting life and action in the old West. These figurines have a vitality and vigor that might be found in the work of a craftsman of the Renaissance. Yet the hands and equipment that shape them are the same that each year repair and fabricate tons of heavy industrial equipment.

The solid body portions are built up with a melted steel rod and then given a lustrous coating of bronze with the bronze welding rod Exact blowpipe control of the direction of the intensely hot flame and skilful manipulation of the welding rod make possible the careful shaping of each figure. The patina, or surface color of the bronze coating, is obtained by varying the flame to get different effects of shading.

AFTER DEATH

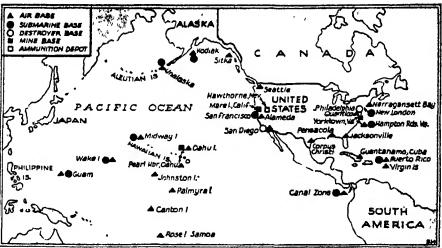
E LECTROCARDIOGRAMS have shown that the heart beats for as long as half an hour after a person is, to all appearances, dead. The stethoscope is not reliable as a means of determining whether the heart's action has ceased. Artificial respiration should be continued until rigor mortis sets in—Health News, New York State Department of Health.

LIGHT-WEIGHT FREIGHT CARS

ANTICIPATING the need for light-weight freight equipment, American Car and loundry Company has developed two new designs of modern light-weight welded steel freight cars. One is a 50-ton all-welded alloy steel box car and the other a 40 ton welded-riveted refrigerator car.

Low alloy, high-tensile, corrosion-resisting steel has been used to the fullest extent practicable in both types of cars, the thickness of plates and shapes being reduced to a minimum while still providing adequate strength. The light-weight of the box car is 37,500 pounds and that of the refrigerator car 44,200 pounds. This represents a reduction in weight of approximately four tons in each design.

New developments incorporated in the allwelded box car include steel ends with extra long corrugations extending around the body



Courtes The New York T men

Careful study has been made by a Naval Board of the coastlines of the United States and its possessions. This Board recently made its report to Congress. The above map shows the Board's recommendations as to sites and types of bases which are deemed necessary. Because of the desire to unify our defense plans, most of these bases will be approved and construction work will be started without delay. At least the nation can count on a vast extension of our system of air bases

end posts, steel doors of increased rigidity, and a new design of under-frame having integral all-welded construction

New developments in the welded-riveted refrigerator car, in addition to those mentioned above, include ice bunker, ice hatch, removable steel bulkhead, a unique and very efficient application of insulation, and a new and economical method of using dry ice in combination with water ice

SLAG IN GLASS

IN India, where soda ash is relatively expensive, experiments have been made to show that the slags of iron and steel plants can be used in the manufacture of glass for many common articles. The slag used is supplemented by orthoclase feldspar. Reduction in the cost of common glass, as made in India, of as much as 50 percent is reported. The glass has been used for bottles, jars, tiles, and such articles—D H K.

PERU'S GOOD-WILL OFFER

DURING the recent session of the Pan American Conference at Lima, Peru, the New Orleans office of the Pan American Society of Tropical Research received an official communication from the Honorable Pedro Recavarren C, Director of Agriculture of the Peruvian Government to the effect that the people and the government of Peru desired to make a good-will gift offer-

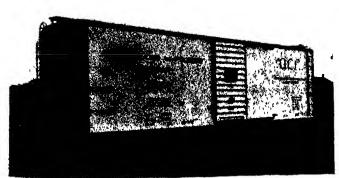
ing, to the citizens of North America, substantially as follows.

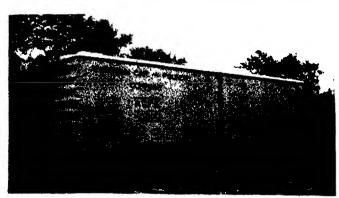
"In celebration and commemoration of the successful International American Conference (Pan American Conference), at Lima, Peru, South America, the people and government of Peru take great pleasure in offering, through the good offices of the Pan American Society of Tropical Research of New Orleans, Louisiana, United States of America, a free, good-will packet of seeds of a beautiful native flowering plant of Peru. This offering is an expression of the feeling of peace and kindness that exists in South America for the people of North America.

"The seeds offered are those of the Mutuy o' Pacte, which is a small plant, bearing flowers of exquisite fragrance and exotic loveliness, that is native to the mountains and highlands of Peru. It is, therefore, hardy and can be grown throughout the latitudes of North America. The color of the flower is a brilliant shade of yellow and the plant blooms for two or three years.

"In connection with the free seed offering of this beautiful Peruvian flowering plant, a pamphlet will also be sent to applicants that will describe the results attained by the Pan American Powers at the recent International Conference at Lima, Peru, and also will describe the country of Peru and carry the message of good-will from the Peruvian people and government to the people of North America."

This pamphlet and a packet of these seeds





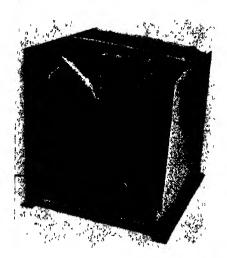
Two new types of freight care constructed of light-weight alloys

will be sent to every person in the United States and the Dominion of Canada who desires them. There is, of course, no charge and no obligation. Send your name, address and a loose stamp to: The Pan American Society of Tropical Research at New Orleans, Louisiana. Eight hundred thousand seeds of this Peruvian flowering native plant are ready for distribution. Peru invites you to write for your free packet of seeds and measage of good-will now.

FUEL TANKS OF FABRIC

THE Glenn L. Martin Company has now developed an aircraft gasoline tank of synthetic fabric which gives definite promise of being vibration-proof and thus insuring higher safety and reliability.

In the "Mareng fuel cell," as it is called, the gas-tight metal fuel tank is eliminated Bags of treated fabric are designed to the shape of the interior compartments of wings, fuselage, or floats, as the case may be, and are inserted in place somewhat as inner tubes are installed in tire casings. These fabric tanks, instead of being tailored to fit their compartments exactly, are cut to patterns which are slightly larger in each dimension than the surrounding walls against which they rest. This over-sizing is an



Above: One of the new fabric fuel tanks for aircraft, showing how it is placed within a metal compartment that serves as a container

Right. Fabric fuel tanks installed in a wing, before the bottom plate is fastened in position

Lower right. The "shaketable" set-up on which airplane fuel tanks are tested to determine the resistance to vibration

important factor, as the fabric liming is thus never subject to stretching or twisting. The cell serves solely as a static, vibration-proof container, all strains and stresses being taken by the structure of the wing fuselage or float

Government specifications require that airplane gasoline tanks shall be able to withstand not less than 15 hours of destructive

vibration on a high-frequency vibrating table, and 25 hours' resistance is the highest requirement in any service. Subjected to this vibration the Mareng fuel cell withstood 700 hours of test unscathed, although to make the ordeal more severe a rocking motion was also imparted to the machine. One of our photographs shows the table to which a high-frequency, low amplitude vibration is imparted while the tank is undergoing test. The arm at the right supplies the rocking motion.

In another photograph is shown one of the fabric cells placed loosely within the metal compartment, which is subsequently placed on the vibrating table. A third picture shows a three-cell fuel tank installed

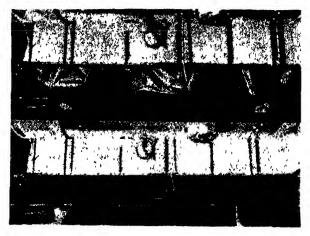
in a plane wing.

Another advantage of the new type of tank 14 that, if pierced by a bullet in flight, the leakage of gasoline is relatively slow Piercing treated fabric results in a slit, rather than in a definite hole. Under the pressure of the gasoline the slit tends to close. On a foreign war front, one of the new Martin fabric tanks was pierced by enemy bullets Instead of the plane being immediately grounded, as would be the case with con ventional metal tanks, it was able to return to its base more than a hundred miles away Still another advantage, besides the climination of gas tightness in the structure, is the fact that corrosion of metal by gasoline is no longer to be feared. Gasoline inside the cells is not in contact with metal, and the synthetic fabric is completely unaffected by

While the new development is perhaps of more interest in military applications, it should add greater reliability to commercial aircraft likewise — 4. K

SEAPLANE TERMINALS

THE Scaplane Flying Association wants the C.A.A. to create a Division of Scaplane Operation to build scaplane terminals and pertinent facilities. If we accept the Division of Private Flying, then a Division of Scaplane Flying is equally logical. The question of costs, and the effect of costs on the



national budget, is something which should always be kept in mind, however, when a new federal activity is suggested.

Even today the C.A.A. is not neglecting the seaplane. Thus, its airport section is developing a new floating marker light, for night operation of seaplanes and flying hoats. These lights have already been tried out in the vicinity of Baltimore, Maryland,

where a 3600-foot landing area was laid out by mooring two rows of twelve lights each, spaced 300 feet apart on the surface of the water. A series of experimental take-offs and landings were successfully carried out within this area with a Douglas Amphibian and two Navy Consolidated Flying boats.

The construction of the light is very simple and effective. It consists of a 39-inch streamlined airplane tire floating on the water, through which a five-foot vertical bronze tube is set in gimbals. A 25-pound battery container is fixed at the bottom of the tube and a mercury-vapor light at the top. An anchor weighing five pounds is made fast to the float with 36 feet of chain, so that it remains relatively stationary in rough water.

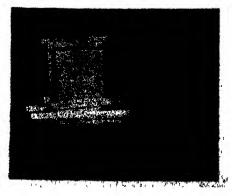
It is believed that the new system of water lighting will reduce surface glare, give the pilot a definite horizon, and indicate the exact surface of the water. It will be interesting to see how the system works out in continued service—A K.

Our Position in Air Defense

POREIGN governments are secretive in matters relating to military and naval aircraft-far more secretive than is our own government--and no comparison of foreign air fleets and of our own air fleet is entirely sound But this is what may be deduced from reports of competent American observers of the European scene, such as Igor Sikorsky, Paul Johnson, and others. In prototype airplanes-that is to say, airplanes which are types and not yet in large production-we can match anything that England, Germany, France, or Italy has to show us. If some single-seater fighters in England and Germany are faster than ours, this is only because our single-seater fighters confront longer distances in service and have to carry much greater fuel supplies. Otherwise, in bombers, multiplace fighters, navy patrol boats, or what not, we are either unsurpassed or definitely ahead. But when it comes to actual airpower, and current production of military aircraft, then it may be said that we lag behind, particularly behind Germany.

Mr. Johnson, with considerable evidence to back up his statement, rates the actual air powers of the great nations as follows: Germany, 10; Italy, 6; Great Britain, 5; the United States, 4; and France, 2. C. G. Grey, in Jane's "All the World's Aircraft," dismisses Russian aviation as negligible, and social experimentation on a vast scale seems to have reduced French strength and current production of aircraft to a very low level.

It is quite apparent, then, that the Administration is fully justified in seeking a great



increase in our air forces and the building of 9000 to 12,000 airplanes in the next two or three years. While the program is ambitious, the productive genius of the United States will undoubtedly be equal to the task. Where we may find greater difficulty is in training flight personnel, and in getting enough mechanics for maintenance and other ground duties. Without adequate ground forces, the mightiest air fleet is help-less.—A. K.

PROPELLER PROGRESS

THE year 1938 was remarkable for many aviation achievements such as the "hydromatic" controllable pitch propeller which keeps the engine running at one particular speed, and at the same time allows the constant speed to be set at any desired revolutions per minute; the electrically controllable propeller; the fully feathering propeller in which the blades can be set edgewise when an engine is out of commission, and the development of a system in which an engine drives one airscrew to the right and another to the left so that engine torque effects are eliminated. In addition to all these advances, the propeller engineers are keeping a jump ahead of the game by building airscrews large enough, yet not too heavy, to absorb the power of the 2000 horsepower engines which are just around the corner.

One of our photographs shows a Hamilton

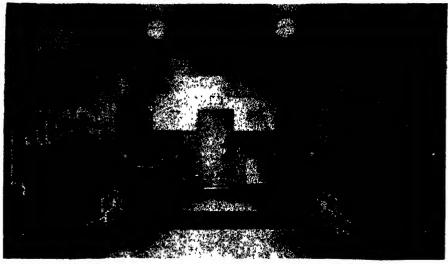


Latest in propeller design

Standard 17-foot hydromatic propeller, the largest propeller ever built, designed for use with airplanes which are still in the drafting-room stage. This 17-foot giant dwarfs the 11½-foot airscrew now in use on the Douglas DC-3 transport. The largest metal propeller actually in use is the 14-foot airscrew employed on the new Boeing 314 flying boat.—A. K.

CIVIL AERONAUTICS AUTHORITY

AFTER some preliminary confusion, unavoidable, in organization, the Civil Aeronautics Authority has got into its stride and is doing good work. Perhaps the most significant innovation of the Authority is the creation of a Division of Private Flying, with Grove Webster as its chief. Mr. Webster will attempt the simplification of air regulations affecting the private flier; develor with attempt the simplification of air regulations affecting the private flier; develor with th





One of the sound-proofed control rooms from which engineers observe airplane motors on test. Left: The flexible cable mounting or supports of powerful engines in their test cells

and flight instruction; maintain contact with private fliers throughout the country; and in general promote popular flying

One of the most important tasks facing the new chief is to help in the provision of inexpensive flight instruction. College students as a class are excellent flying material, and are just at the right age-old enough to have discretion, young enough to pick up flying quite readily. But they are not at the earning stage, and parents refuse to provide the 200 or 300 dollars necessary to learn to fly. If Mr. Webster can help the formation of clubs, arrange for payments to those who have solved or otherwise reduce the financial liabilities of a college boy learning to fly, he will undoubtedly increase the number of amateur pilots by thousands. It will be interesting to see what policy is finally evolved .- 4. K.

TESTING AIRCRAFT ENGINES OF 3000 Horsepower

AIRCRAFT engines are constantly increasing in power, and the Wright Aeronautical Corporation is putting into production double-row Cyclone engines rated at 1500 horsepower, the highest ever accorded an aircraft engine of any type by the Civil Aeronautics Authority, And, of course, the engineers and constructors will not stop at even this immense power.

These powerful prime movers are based

on the most exhaustive research, and among other problems there is that of testing, particularly of testing many powerful engines simultaneously for long periods of operation. To meet the situation, a building has been constructed, enclosing a battery of 14 test cells, each of which is capable of testing an engine up to 3000 horsepower, swinging huge propellers up to 20 feet in diameter.

One of the most interesting features of the new equipment is the investigation of air effects on the engine under high-speed flight conditions. When air enters the carburetor at 200 miles an hour, there is a powerful "ranning" effect. A blower connected to the carburetor air intake enables the test engineers to simulate this "ramming." The blower is also equipped with controls by means of which the air fed to the carburetor may be "thinned" out to simulate flight at high altitudes. The air may also be heated or cooled to represent varying atmospheric conditions.

The test cells are built in pairs and are separated by control rooms on each side of which are tables on which are mounted the throttles and a variety of instruments for checking power output, fuel and oil consumption, cooling, and so on. A glass window above the instrument board gives the test engineer an unobstructed view of the test cell and the engine.

Soundproofing is another problem. The inhabitants of Paterson, New Jersey, used to complain bitterly of the unendurable noise created by engines undergoing test. The walls of the building are now so massive that no noise can penetrate them, but the inlet and exhaust air must be rendered incapable of spreading sound waves into the surrounding atmosphere. Hence the towers at each end of the test cell, which extend 30 feet above the ground, are provided with a great concentration of sound-absorbing material. The offices of the test engineers are also most carefully sound insulated.

A new method of mounting the engines has also been developed which simulates actual flight conditions much better than the ordinary framework of structural steel bolted to the floor. A steel tube is used instead. This tube is suspended from the ceiling

by four cables and anchored to the floor by two more. Cradled in rubber, these cables provide a flexibility in the engine mount which could not be obtained with a rigid test stand. They also prevent the transmission of vibrations to the walls of the structure.—A. K.

X-RAY TIRE INSPECTION

WITH the attention of every safety organization and every safety official in the nation concentrated on ways and means of making street and highway travel safe for America's 30 million motor vehicles. The Firestone Tire & Rubber Company anounces the introduction of a new motoring safeguard—the tire X ray

This new application of the X ray, a bene



Looking through a tire

factor of man ever since its discovery in 1895, will enable car owners to checkmate most of the 40 million flats that are now occurring annually. With this equipment only a few minutes are necessary to X ray a set of tires. The operation is simple. No pictures are taken. The owner looks directly through his tires without removing them from the wheels.

In an experimental test, engineers X rayed the tires on 100 automobiles. The tire X ray revealed that 99 percent of these carscarried one of more hidden tire dangers. A further investigation of 2000 worn tires produced 2049 nails and tacks, 2099 pieces of glass, and 2197 pieces of rock and small stones which had become lodged either in the tread or deeper in the body of the tire. In addition, a considerable number of tires showed breaks in the cords as well as other defects that would have eventually resulted in a flat, or possibly a blowout.

Detection of these under-cover hazards with the Firestone tire X ray is a simple procedure. The automobile is elevated several inches above the floor and the tire X ray is rolled under one wheel Protective flaps are adjusted to confine the rays to the section of the tire that is being inspected. The operator tirms a crank which rotates the entire wheel. When any foreign object or defective section of cord is revealed, it is immediately spotted, automatically marked, and the inspection continues. Once located, the foreign objects are quickly extracted with special tools after the tire X-ray inspection has been completed.

In addition to its value as a safety factor,

the use of the tire X ray adds mileage life well beyond the normal expectancy of a tire that does not receive X-ray inspection. Glass and nails in the tire body, agitated by every revolution of the wheel, weaken the body structure After miles of travel in this condition the tire is permanently injured, even though the tube itself may have remained intact. Thus tire X ray is not only a life saver. It is a money saver

RESEARCH

ON industrial and engineering research there was expended during 1938 about \$180,000,000, according to an estimate by Dr. W. A. Hamor, of the Mellon Institute.

PEELING POTATOES BY FLAME

PRUDGERY and waste are being taken out of peeling potatoes by a new process in which the tubers are exposed for a few seconds to a flame temperature of 1750 degrees, Fahrenheit. This almost instantaneous heating of the peel blisters and chais it so that a high-pressure water spray can remove it completely from the potato. Eyeand blemishes must be removed by hand subsequent to peeling. This process is being applied to potatoes and other vegetables for hotels and restaurants using large quantities—D H, K

WIRELESS RECORD PLAYER FOR RADIOS

DEVELOPMENT of a wireless record player which combines in compact form the virtues of a fine phonograph and the flexibility and control advantages of the modern radio receiver has been announced by the radio division of the General Electric Company

The new record player was designed to meet the demands of the modern home for a musical instrument which will play with-



Self-contained wireless record player for use with any radio receiver

out interruption the outstanding recordings of the day. No sound issues from the cabinet of the record player itself during its operation; the automatic electric sound reproduction and control devices of an existing radio receiver are employed, thus utilizing the owner's previous investment to greater advantage. Despite this use of the home radio receiver, however, there is no wired connection between radio and record player, a fact

which makes the performance of the device almost uncanny to the observer.

This accounts also for the flexibility of the record player since in practice it can be used effectively with any radio within hearing distance. From a single location in the home, where it is plugged into the household circuit, the music from records being played can be heard from a receiver in the central living room, or from small sets in a play-



With no connecting wires

100m, or in upstairs bedrooms, or on an outside terrace.

Most radio receivers built by General Electric for 1939 are equipped with a special key, or button, which is pressed when the record player is in operation. This makes available an unoccupied section of the broadcast band. On other sets, however, it is only necessary to set the dial at a "dead" spot in the broadcast band, with the power on. The record player acts as a small broadcasting station, transmitting the electric impulses represented by the record to the radio receiver, whence they emerge as sound Provision is also made in the new record player for the attachment of a small microphone, enabling users to "broadcast" to their own radio, from which their voices emerge.

INEXPENSIVE AIR FILTER

DESIGNED primarily for removing pollen from air, but equally effective for removing dust, soot, and lint particles, is a new low-priced air filter offered for home and office by Norris Industries, Inc. Tests in a hospital room show a pollen count of 1159 outside to be reduced to three per cubic yard inside.

The purifier comprises a weatherproof casing with two Burgess filters, and fittings to make it adjustable to all but casement windows. By using any ordinary 10-inch household fan, which is placed inside the casing, 200 cubic feet of air per minute are driven through the filters. Through a unique arrangement of louvres in the sides of the casing, air from the room is re-circulated and cleaned. Thus 125 cubic feet of fresh air are drawn from the outside and filtered, while 75 cubic feet are being re-filtered to maintain dust- and pollen-free surroundings. Unless operating in very dirty surroundings, filters may last a season, but can be replaced economically.

TEMPERATURE CONTROLLING METAL

A NEW alloy of iron, nickel, thromium, and silicon developed at the Battelie Memorial Institute has the remarkable prop-

erty of losing its magnetism at a definite temperature which can be predetermined beween 1100 degrees, Fahrenheit and -150 degrees, Fahrenheit. At the critical point, where the metal loses its magnetic properties, it goes through a phenomenon to which the word "shivering" has been applied; when this occurs it can be utilized to control electric circuits or operate other temperature controlling devices. The temperature at which this change occurs in the metal is established by the proportion of the various constituents in the alloy.-D. H. K.

Nozzle for All CLASSES OF FIRES

NEW type of nozzle that is especially A desirable for general use on fire-hose bnes because it permits the use of water in large quantities for extinguishing all classes of fires, including fires in oils and in live, high-voltage electrical equipment, has been developed by American-LaFrance-Foamite Corporation, manufacturers of fire protection equipment, Elmira, New York

This new device, which is known as the Poweron nozzle, discharges water in a discontinuous spray that is especially effective for fire-fighting purposes and does not conduct electricity. It cannot be adjusted to throw a solid stream of water Tests conducted by the Underwriters' Laboratories showed that the nozzle is suitable for use on equipment carrying current at voltages as high as 250,000

The Poweron nozzle is similar in size and appearance to the ordinary fire-hose nozzle and can be attached to any standard fire hose. Its special form of discharge, besides being more effective than a solid stream of water, forms a water curtain between the operator and the blaze. The nozzle is non-adjustable

TUNNEL LINING

THE Chain Belt Company, of Milwaukee, L recently shipped one of two Rex Tunnel Lining Machines for concreting operations on the Gunpowder Fall- Montebello Tunnel which is part of the water supply system for the city of Baltimore. This tunnel will extend a total length of seven miles with an inside diameter of 12 feet and will require about 70,000 cubic yards of concrete. There will be two principal shafts from the surface through solid rock to the tunnel, each about 200 feet deep and spaced at two-mile intervals from Baltimore.

To handle this concreting job, the company designed and constructed two tunnel lining machines. These units are modeled along the general line of the Rex tunnel machines used on the Metropolitan Water Dis-



Left The new spray nozzle that holds great advantages for fighting any fire. Above: A demonstration that shows the type of spray

car through a lever and cable arrangement which is part of the mixer car.

The machine is powered for DC. operation, and all of the controls are conveniently placed to operate from a platform on the mixer car.

The two complete tunnel lining units will be operated independently of each other inside the tunnel and each unit will have a fleet of 15 batch cars serving it. The contractor plans to div-batch his aggregate and cement on the surface, and drop the batch down a pipe through the shaft and through a transfer bin into the batch cars



trict project in Southern California, with, however, some very definite modifications to adapt the equipment to work in a 12-foot

There are two separate car-a mixer car weighing approximately 18,000 pounds and Pumperete car weighing approximately 16,000 pounds. Each car is on flanged wheels with individual traction drive to operate on 36-inch gage tracks. The two cars are designed to work close-coupled as shown in our illustration.

At the extreme right is one of the batch cars which will be used to charge the mixer. The batch body has a capacity of two 11/4cubic vard batches. As the car is backed up to the mixer, two arms from the mixer car engage the body and hoist it into charging position. The body is lifted from the batch

MILK

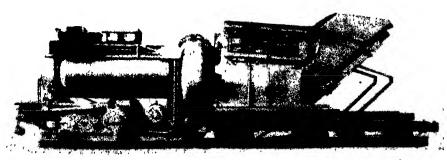
MORE than 100 billion pounds of milk are produced and consumed in the United States each year. The average in recent years has been 106 billion pounds.

Eighty-One Cents' WORTH OF DIRTY BUSINESS

BECAUSE a user with a laudable curiosity complex wanted to know how much it cost to operate a vacuum cleaner for a year, approximately 200 housewives were called upon to answer her and the figures were recently revealed by R. F. Sambleson, commercial engineer of General Electric's vacuum cleaner section at Bridgeport, Connecticut.

The average cost of power in the United States is roughly five cents per kilowatthour. A regular floor type cleaner uses .325 kilowatts, and a hand type only .200 kilowatts. The G-E engineers figured 50 hours of actual cleaning a year as a reasonable basis for their computation, which makes the operating cost of the floor type 81 cents a year, and that of the hand type 50 cents.

Then, just to check their usage figures, 200 cleaners were put into actual home use for a year, with timeclocks on them to measure the time during which the motor



The tunnel lining unit is made up of two separate cars as described



Above: Cherry trees, growing in incubator bottles under aseptic conditions, will later be transferred to pots. Below: Incubated peach seedlings after transplanting



was running. The average figure turned out to be only 33 hours, which would make the annual operating cost a third lower than previously supposed. Either this is a tribute to the efficiency of the cleaner, in Sambleson's opinion, or husbands should begin checking up on the time-honored statement that "woman's work is never done." In either case, 81 cents is the top figure, and that wouldn't even buy a good broom.

SHRINKPROOF WOOLENS

W OOLEN blankets made proof against shrinkage by treatment with a solution of sulfuryl chloride in dry cleaning solvent have been recently put on the American market. The treating process is English and is known as the Hall process.

Conducted under rigid control, the simple treatment of woolen goods by immersion in a sulfuryl chloride solution of proper concentration acts on the serrations of the individual fibers and makes the fabric permanently non-shrinkable. After treatment, the fibers are stronger, slightly whiter, and somewhat softer than untreated wool. Several manufacturers are offering woolen goods which can be guaranteed against shrinkage so long as the treatment given the fabric does not destroy the fibers themselves—D. H. K.

GROWS FRUIT TREES IN "INCUBATORS"

DIFFICULTIES encountered in the course of the fruit-breeding work in progress at the State Experiment Station at Geneva, New York, particularly with respect to developing early ripening varieties of the stone fruits, have given rise to a so-called "incubator" method of handling the embryos of fruits that would otherwise be lost. "In cubator" fruit trees have reached maturity and are now bearing fruit on the Station grounds.

A brief popular description of the men-

bator method of growing fruit trees was given by Dr. H. B. Tukey in a recent issue of Farm Research, the Station's quarterly magazine, "Breeding fruit trees by 'incubator methods,' as it has been called," he says, "consists in removing the embryo from the mother fruit during the growing season and placing it in an 'incubator' bottle under aseptic conditions, properly nourished with various salts and a sugar supply, with the result that a new seedling fruit tree is produced which is a potential new variety." By this method the Station fruit breeders have saved many stedlings which might otherwise have died.

The method has proved most valuable in saving seedlings from crosses of early ripening peaches, cherries, plums, and apricots. Heretofore, most of the embryos of crosses of very early ripening varieties of these fruits have failed to develop properly and much or all of the cross has been lost. By removing the embryos at the correct stage of development and nursing them along in the incubator bottles, the Station now has a number of potential new varieties of these fruits well along the road to maturity, while some few of them are actually beginning to bear fruit

The method has found another unexpected but very useful application in the nursery industry, as a germination test of fruit tree and forest tree seeds. By this method the percentage germination of the seed can be determined within seven to ten days as compared with a period of several months under ordinary conditions. It is also supplying much valuable information on the growth habits of fruit embryos which will doubtless prove helpful to plant scientists.

ALCOHOL IN ICE CAPS

To simplify nursing routine by eliminating numerous time-consuming operations, one large hospital is standardizing on the use in ice caps and collars of a 10 percent alcohol solution in place of the conventional cracked ice, according to the American Jour-

nal of Nursing. The solution freezes at minus 4 degrees, Centigrade.

Each cap is filled with 500 cubic centimeters of a 10 percent alcohol solution and, the article states, takes from 60 to 90 minutes to freeze in electric units employed by the hospital. Used ice caps are washed with soap and water, dried and then returned to the freezer. It is not necessary to remove the solution, according to the article.

Tests over a five-year period in an 18-story surgical building, with an average census of 250 patients and a five-room operating suite, are said to have convinced authorities of the economy of the measure.

The mixture produced by the freezing of the solution is described as firm but easily broken up by hand to make the cap conform more readily to body contours.

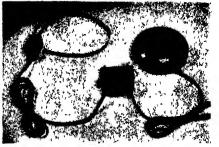
LAMPS

FOUR fifths of a billion—800,000, 000—incandescent lamps were sold in the United States during the year 1938, Of these, 485 million were of the everyday kind.

MINIATURE TELEPHONES AID HEARING

As a result of many years of research and development work in artificially reproducing speech, Bell Telephone Laboratories have perfected a new type of hearing aid, known as the Ortho-Technic Audiphone. The newly perfected device, so small it can be concealed on the person, is actually a miniature telephone of the most improved type

After the sound waves are picked up by the efficient "transmitter," they are amplified



A typical Audiphone combination using a bone conduction receiver. Below: Ear pieces for air conduction receivers are supplied in universal types or may be molded to order to suit the individual ear



to a suitable strength and led into a miniature "receiver," which repeats them at the point where they may best actuate the organs of the inner ear. For this purpose, it may be advisable to locate a diminutive receiver in the outer ear, or it may be more advantageous to locate it against the head immediately behind the ear, where it will transmit the sound vibrations through the bony structure to activate the hearing organs within. This, and selection of the proper units to comprise the most effective Ortho Tantale

1 11.18 3.18 4

For MEN

reho reant to become independent in the NEXT TEN YEARS

IN the Spring of 1949 two business men will be sitting in a mid-town restaurant. "I wonder what's going to happen next year," one of them will say. "My business is fine now-but the next few years are going to be hard ones, and we may as well face the facts."

The man across the table will laugh.

"That's just what they said back in 1939," he will answer. "Remember? People were looking ahead apprehensively-and see what happened! Since then there has been the greatest growth in our history-more business done, more fortunes made, than ever before. They've certainly been good years for me."

He will lean back in his chair with the easy confidence and poise that are the hallmark of real prosperity.

The older man will sit quiet a moment and then in a tone of infinite pathos:

"I wish I had those ten years back," he will say.

• Today the interview quoted above is purely imaginary. But be assured of this-it will come true. Right now, at this very hour, the business men of America are dividing themselves into two groups, represented by the two individuals whose words are quoted. A few years from now there will be ten thousand such luncheons and one of the men will say:

"I've got what I wanted." And the other will answer:

"I wish I had those years back." In which class are you putting vourself? The real difference between the two classes is this-one class of men hope vaguely to be independent sometime; the other class have convinced themselves

CONTRIBUTORS TO THE COURSE

Just a few of the business leaders who have contributed to the Institute training course are such prominent men as:

nan of the Board U S. Steel Corp.

Alfred P. Sloan, Jr. Chairman of the Baard General Motors Corp.

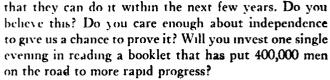
Major B. Foster

to we apply the state of

I dward R. Stettinius, Jr. Thomas J. Watson Pres., International Business Mach. Corp

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This booklet costs you nothing-and for a good reason. It is worth only what you make it worth. It explains how

> for more than thirty years it has been the privilege of the Alexander Hamilton Institute to help men shorten the path to success; to increase their earning power; to make them masters of the larger opportunities in business.



"PORGING AHEAD IN BUSINESS" is an interesting helpful booklet. It is yours for the asking Send for it. Measure yourself by it, Look clearly, for a few moments, nto your next few years. Whether or not you will follow the path it points is a matter that you alone must decide.

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nut cost a copy of "Forging Ahead in Business

Business Position

In Canada, address Alexander Hamilton Institute, Ltd., C. P. R. Bidg., Toronto, CanAudiphone combination, is decided after an analysis of the subject's hearing activity by means of the Audiometer test.

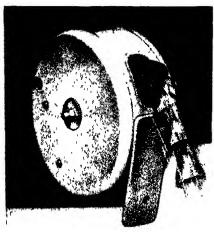
The Audiometer is an instrument specially designed and built to analyze an individual's hearing acuity. Through a test by this instrument, comprehensive information is obtained regarding the relative response of the individual's hearing organs through air conduction and bone conduction.

The new Ortho-Technic Audiohone operates efficiently in any position, regardless of whether the wearer is reclining, sitting, or standing The user need not be confined to conversations with an individual, for he may participate freely in group conversations. By manipulating the convenient "volume" control, he may enjoy the loud music of a brass band close at hand or he may understand completely what is being said by a person speaking in normal tones on the opposite side of an ordinary sized room. Because it consumes less power than previous designs, the new device does not require replacement of batteries as often, which makes it more economical in operation

AUTOMATIC REELS FOR ELECTRIC CORDS

A MODERN and inexpensive solution to the old problem of daughing, unsightly extension cords on electric appliances and electric equipment is made possible in the new Cordomatic-automatic cord control reel—just announced by The Cordomatic Division of the Vacuum Cleaner Corporation of America.

Made in a variety of sizes and designs for either external or concealed mounting. Cordomatic reels are complete, fully enclosed,



No more twisted electrical cords

self-contained units, ready for installation. They maintain the exact needed cord length at all times, eliminate cord wear, keep castors from damaging the cord, stop kinking and tangling and avoid danger of accidents from dangling coils. The cord is paid out as required and then is retrieved automatically and wound inside the metal container where it is out of sight, out of the way.

BASEMENT GREENHOUSE

A BASEMENT, glass-less greenhouse which holds interesting possibilities for profitably utilizing basement space in homes in congested areas, has been designed by Professor Alex Laurie, of Ohio

State University. It is not intended to supplant the familiar greenhouse, but merely to serve as a propagating house and for "finishing off" plants which have been brought almost to the blooming state in pots. A series of tests were made to determine its fitness as a propagating house and cuttings of carnations, geraniums, chrysanthemums, and many other varieties



In a basement

were successfully grown in clean, sharp propagating sand

For those who might wish to build a basement greenhouse as a propagating house, the construction is of the simplest Walls of pressed wall board are nailed on each side of two by four partitions, the dead space between the double walls acting as an insulating area against both heat and cold The inside walls of this simple greenhouse are painted white to reflect the maximum of light from the 100-watt Mazda lamps which are installed two feet apart and suspended two feet six inches above the propagating bench. These are operated 12 hours a day by automatic clock, Electric soil-heating cable is installed on the benches and is thermostatically controlled to maintain the soil temperature at 73 degrees, Fahrenheit.

A fresh-air inlet from outdoors is installed at floor level with an exhaust fan at the ceiling. A thermostat control actuates the fan when the temperature rises above the desired level and stops it when the temperature drops to normal Frequent syringing of the plants is necessary in order to maintain humidity at a desirable dew point and, in addition, trays of water are kept for this reason under the benches—C F Greeves-Carpenter

THRESHOLD TREATMENT OF WATER

RECENT investigations initiated to prevent caking in valves and distributing lines of irrigation systems, caused by the addition of small amounts of ammonia to hard water, have proved the high value of minute doses of sodium hexametaphosphate as a preventive. This treatment, called threshold treatment because so little water softener is used, has not only permitted the economical distribution of ammonia as fertil-

wer in origation water supplies but has shown the way to prevent incrustation in other water systems.

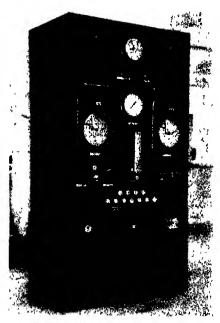
As little as one or two parts of the metaphosphate in a million parts of water effectively prevents the precipitation of calcium carbonate and other salts in water systems. The development of the threshold treatment is so recent that new applications are being found daily. In Ohio, the water supply of a city is being treated to prevent incrustation of the filters in the softening plant and of the distribution system throughout the city In Illinois, a river which flows continuously through the condensers of a large commer cial distillery is subjected to threshold treat ment so that the condensers will not scale up. In Texas, where the condensers on the cracking stills used to plug up solid in one month, the use of metaphosphate has prevented scale, allowing the units to run indefinitely. In state after state where hard water supplies are encountered, the railroads and the steam power plants are using this phosphate glass in what seem like ridic ulously small amounts to avoid operating difficulties resulting from calcium carbonate

The development of the uses of sodium hexametaphosphate in the conditioning of water is purely an American achievement, although this substance was first studied by the British chemist, Thomas Graham, over a century ago—I) II K

CO-ORDINATED PROCESS CONTROL

INDUSTRIAL instruments give close control for carefully planned processes Bristol's system of co-ordinated process control is an automatic machine which controls process operations, where instruments—in dividually operating to control such process variables as temperature, pressure, liquid level, flow, humidity, and motor or machine speed—are co-ordinated and interlocked into a single control unit so that they per form operations in successive steps and proceed in the proper sequence as required by the process

The system is exceedingly flexible and is, therefore, used to control a number of dif-



For co-ordinated process control

ferent types of manufacturing processes. Those already in operation may be placed under supervised control or those newly developed and previously perfected in the laboratory and pilot plant may be put into automatic production on a full-scale basis. Such control prevents deviation from the original plan and eliminates the chance for error resulting from manual supervision.

This new system of co-ordinated process control consists essentially of a multiple cam cycle controller, or "Mechanical Brain," which controls through the medium of compressed air and by means of leakless pilot valves and cams. Around this cycle conttoller, standard recording and controlling instruments are built to operate valves (all sizes up to large gate valves), pumps, blowers, dampers, and electrical equipment By means of the cycle controller, the operation of these instruments is controlled to a time program, so that the devices to control such variables as time, pressure, liquid level, flow, humidity, speed, and mechanical motion, may be operated automatically, according to the schedule found to be responsible for the best over-all results. In this way the system provides for a carefully planned machine, built in the form of a suitable panel board, to control, automatically, involved processes where the human element in supervision may best be eliminated

Molasses as Fertilizer

W ASTE molasses is being used as a source of nitrogen for fertilizing Hindu soils Good results have been obtained using dosages as high as 30 to 40 tons per acre - D II K

HYDROGEN

B ECAUSE it is only about a tenth as heavy as air, hydrogen, used inside the casings of great electric generators to cool them, reduces the windage, or friction, of their giant rotating shafts to one tenth that of air. Hydrogen is thus a vital factor in increasing power efficiency.

OLD AGE CAN WALK— CAN'T SPRINT

THE inability of an old man to sprint 100 yards although he may be able to walk all day as well as in his youth is due in part to loss of capacity to accumulate factic acid in exercise, according to Dr. David Bruce Dill of the Fatigue Laboratory of Harvard University.

Lactic acid in the body, Dr. Dill explains, is a fuel for muscular contraction which has sometimes mistakenly been spoken of as a "fatigue substance."

"It may be that the heart has a greater capacity for work in severe exercise than ordinarily because of the high concentration of lactic acid in the blood pouring through it," Dr. Dill continued. "Dr. Robert Johnson in the Harvard Fatigue Laboratory has found that lactic acid, however rapidly it passes out of muscle cells, enters the red cells of the blood very slowly; so slowly that after one or two minutes of severe exercise nine tenths of the blood



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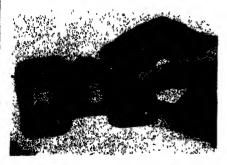
"The capacity to accumulate lactic acid in exercise is lost in old age. A man of 70 may have one half the capacity for carrying on work in a steady state which he had in his prime, but his capacity for work carried on after the supply of free oxygen in the blood is depleted is almost lost. There are many illustrations of this-many men of advanced years can walk all day as well as in their youth, but sprinting for 100 yards would be impossible. De Mar at 49 ran the marathon as well as at 22, and Cunningham runs the mile at 29 better than at 22, but who knows a successful sprinter as old as 29?"

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HE enthusiasm that has been shown in various countries for synthetic wool made from the casein of milk has been dampened by the discovery that certain bacteria will destroy casein even after it has been woven into a garment. Synthetic wool garments require no moth balls to protect them, since moths do not attack casein. Synthetic wool, however, may be destroyed by bacteria, against which moth balls are no protection. Obviously the present fabrics used in Italy which are made up of half wool and half synthetic wool are vulnerable to both attacks .- D. H. K.

"Everything Flows"

YEW clues to the underground mechan-ism causing earthquakes, mountain formation, and other geological phenomena have been found by a Harvard physicist in the action of rocks under tremendous laboratory pressures.

David Griggs, junior fellow in geophysics, has utilized the high-pressure equipment of Prof. P. W. Bridgman to duplicate the pressure conditions in the earth's outer crusta granitic layer extending down 30 to 50

Under the high confining pressures, which

or in Ash A. Charles Adams

reached a maximum of about 300,000 pounds per square inch, it was found that limestone could be made to flow. A small block of it was compressed 35 percent in length without shattering. Contrary to past geologic beliefs it was found that, under high pressure, rocks will not flow indefinitely but will break if deformation is carried far enough.-Science Service.

LIFE-SAVING BELT

AN inflatable, chemically-operated rescue belt has been developed by Lyf-Boy Corporation. This consists of a belt, a part of which may be inflated with a gas from a self-contained chemical. In use, the belt



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is fastened around the chest of the drowning person by the lifeguard, who then squeezes the belt to start the inflation, Buoyancy is thus provided for the victim so that the lifeguard may tow his charge ashore by means of a hair-carry or a chin-carry.

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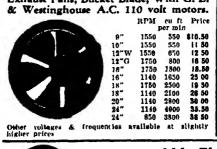
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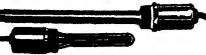
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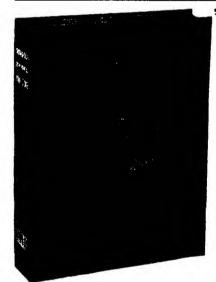
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successively disappear and the cycle is repeated.

Such a system possesses this very important feature: both automobile and pedestrian traffic can judge the time during which a particular signal will operate. Motorists see when to prepare to go, and the pedestrian sees how much opportunity remains for crossing. There is only one illuminated area instead of three, and there is no amber light to be abused.—Highways and Bridges Magazine, London.

A traffic light of similar principle was recently demonstrated in Massachusetts. This signal consists of an aluminum encased circle of 16 bulbs, 15 white and one red. The lights indicate the number of seconds before the light is to change. It is reported that the signal "circle" may be attached to any ordinary traffic signal.

ELECTRICAL POULTRY FARM

ON the chicken farm of Charles F. Wendig, near a swank colony of artists and writers at New Hope, Pennsylvania, electricity is now at work waking chickens in the morning, keeping the young warm, heating their drinking water, providing them with a 12-hour-light day, mixing their feed, sterilizing their air, cleaning their eggs and grading them, and putting them to bed at night. This is but a partial inventory of electric wired helpers, which have transformed the Wendig enterprise into the first Westinghouse Electric Poultry Proving Farm

DYLING WITH GOLD

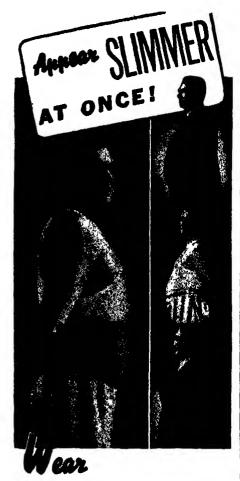
A NEW process of depositing gold on fabrics, which resembles the ordinary dyeing process, has recently been developed. The fabric is dipped in a solution containing a complex organic compound of gold (trialkylphosphine aurous chloride) and on heating becomes coated with a thin, even deposit of gold left by decomposition of the dye—D H K

THE ENGINEER: A DEFINITION

"AN engineer is one who, through application of his knowledge of mathematics, the physical and hiological sciences, and conomics, and with aid, further, from results obtained through observation, experiences, scientific discovery, and invention, so utilizes the materials and directs the forces of nature that they are made to operate to the benefit of society. An engineer differs from the technologiet in that he must concern himself with the organizational, economic, and managerial aspects as well as the technical aspects of his work."—Dr. Karl T. Compton.

BETTER SWITCHES

E NGINEERS have long recognized the unsatisfactory operation of switches with breaking points exposed to the air. Circuits carrying heavy loads are difficult to open because the arc and high temperature causes pitting of the contact points. On circuits carrying lighter loads, dust and cor-



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rosion are the enemies of the points. When the first mercury switch appeared, it seemed to be the solution of these problems. In principle, it controlled circuits with sealed contact points preventing exposed arcing. Also, since each contact was made through fresh points of mercury that was sealed to prevent corrosion and dirtying, such a switch should last indefinitely.

However, ordinary mercury switches had many faults that prevented their general use The use of a metallic envelope together with a non-flammable and non-explosive liquid



Metal shell mercury switch

fill in the Durakool metal mercury switch overcomes the faults of the usual mercury switch

Durakools are perfectly cylindrical so that they may be turned through a full 360 degrees on their long axis without changing their operating characteristics. That is to say, any side up is the right side up. This is not true with ordinary mercury switches Also, the principles in these new mercury switches allow them to be built and used in sizes up to 200 amperes. This is by far the largest mercury switch ever commercially available so far. They are being rapidly applied to an astonishing variety of mechanical equipment ranging from tiny humidity controls to gigantic concrete mixers used on the Conchas Dam. There are at present about 5500 known applications where Durakool mercury switches will serve satisfactorily, including control of many kinds of machines, pumps, clocks, scales, com-operated machines, and many other devices

FIRE-WALKING

(Continued from page 138)

fairly quickly, and stepped off at the side, stating that the fire was too shallow.

Afterward, however, he walked the same fire three more times, but with fewer and quicker steps. His feet were again examined and found uninjured Thirty minutes later there was likewise no sign of blistering. He refused to walk again, the fire being "not to his liking

At the suggestion of one of the physicists the "cotton test" was applied. Human flesh scorches at a lower temperature than cotton fabric, so some calico was wrapped around a wooden shoe last This imitation foot was "walked" upon the embers and in a second the calico was scorched, while in two and one half seconds the cotton was burned through in several places.

Digby Moynagh, editor of St. Bartholomew's Hospital Journal, who was present, decided to try the feat and momentarily placed one bare foot in contact with the embers. "His foot tingled for a considerable time afterward," Harry Price states. Next he walked two paces on the embers but jumped out, said it was "hot" (1) and that his feet tingled. For some time he felt noth-



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ing further, but in 30 minutes blisters had formed on the soles of his feet. He had walked more quickly than Kuda Bux. As will be seen later, undue haste in walking on embers may result in unnecessary burns. Moynagh's weight was 168 pounds, that of Kuda Bux, 120. There is a suspicion that weight has some bearing on fire-walking and that a very heavy person should not attempt it.

For a second test of Kuda Bux, one ton of firewood, seven tons of oak logs, and a load of charcoal were provided. The trench was reduced to nine inches in depth, widened to six feet and, at the request of Kuda Bux, its 25 foot length was broken in the middle by a platform of earth, thus altering it to two 11-foot trenches in line, with a three-foot space between.

Eight days after the previous tests the second were undertaken. The wood was ignited and after a few hours the glowing embers just filled the trenches flush with the ground. "We spent the morning feeding the flames," Price states, "and by one o'clock the pits were a mass of red embers, radiating a heat sufficient to be distinctly felt at a distance of 65 feet on the leeward side of the trenches. The assistants and rakers were compelled to wear goggles and the rakers used shields constructed from the sides of packing-cases. "It was blowing half a gale and, as the wind swept across the fires, they were fanned almost to white heat, ash in the form of powder being blown in clouds from the surface of the fires."

The load of charcoal was then added and in 20 minutes was cherry red. Kuda Bux was examined by Prof. C. A. Pannett, also by the three physicists who were present, Dr T. E. Banks, G. Smith of the London School of Hygiene and Tropical Medicine, and C. R. Darling who was recommended by the Institute of Physics. A number of other scientists were present, some from the University Council. Prof. Pannett, after examining the feet of Kuda Bux, stated that the soles presented no unusual features. The skin was not callous, but soft. The feet felt cold to the hand, and a skin thermometer applied to the soles registered 93.2 degrees, Fahrenheit. The skin was very dry. The feet were then washed and well dried and a small square of zinc oxide plaster was attached to the sole near the arch, to permit observation of any possible effects on its fabric due to the fire.

Seven hours after the eight tons of wood had been lighted Kuda Bux made the first walk, covering only the first 11-foot section of the divided trench. This he did in 4.5 seconds by stop-watch and in four strides—deliberately, steadily, fairly quickly. The records taken by the physicists give approximately one half second during which each foot was in contact with the embers.

Afterward, Kuda Bux's feet were found to have a temperature of 93 degrees, alightly lower than before the fire-walk, probably because he had taken a few steps on the cool grass outside the trench, after walking the fire. His feet were in no way injured and the plaster patch was untouched except at the edges where loose fluff was lightly scorched. He then took four more strides on the fire but no injury was found either immediately or 48 minutes later when his feet were re-examined.

How hot was the fire over which Kuda Bux walked? The physicists responsible for the measurements used a thermo-couple and 417 77

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the temperatures were as follows: Surface, 430 degrees, centigrade, or 806 degrees, Fahrenheit. Body of the fire, 1400 degrees, centigrade, or 2552 degrees, Fahrenheitwhich is a white heat temperature; in fact, steel melts at slightly lower temperature than this. It was owing to the high wind on the day of these tests that the embers reached so intense a heat. In fact, Kuda Bux, after preparing to walk a third time, asked for five minutes' grace, and then said he could not do it again "Something inside me has broken. I have lost my faith and if I do it again I shall burn myself." He looked worried and nervous and Price did not press him to do the walk a third time. And, at that, Kuda Bux no doubt was using excellent judgment. For Dr. E. H Hunt, who was present, and had seen ceremonial fire-walking in India, stated that the test was made under unusually severe conditions, such as the high wind making the heat intense, which would have deterred most fire walkers.

Digby Moynagh, the novice who had tried the feat on the occasion eight days before, next took two steps on the fire but stepped off the trench. He was examined by Prof. Pannett who reports that "the soles of his feet had numerous healing blisters on them. He acquired some more at the second attempt. His skin was moister than the Indian's and this may have had some influence, because afterward a small piece of charcoal was found stuck to the skin, and on its removal a blister was found underneath" He had also walked at a quicker pace than Koda Bux. The last two points are worthy of note, for other instances of each turned up in the course of the subsequent experiments. The first point, with regard to dampness causing hot embers to adhere to the soles, disposes of the "spheroidal state" question, discussed earlier. The second, regarding undue haste, seems to imply possibly that this haste leads to uneven pressure of the feet on the fire. As will be seen, the amateur who finally learned to do fire-walking without self-injury avoided f. antic haste and kept cool. No doubt he discovered an ideal balance between the extremes of haste and its opposite.

Next, Maurice Chapeen tried fire-walking, taking two short, quick steps. His feet were badly blistered and also were bleeding at three points, the latter due possibly to the burnt skin rubbing off the soles of his feet as he hurried out of the trench. His weight was 163 pounds.

Harry Price states that he took a slowmotion picture of the performance and ascertained from it that Kuda Bux had walked much more slowly than the amateurs.

Summing up, Price states that "the poor thermal conductivity of wood ash is not a factor necessary for success; the ash was carefully removed before each walk." And that no one portion of the skin is in contact with the hot embers for as long as half a second. Subsequent observations modified this.

In the more recent of the two London fire-walking reports, named earlier in a footnote, G. Burniston Brown, Ph.D., describes three further fire-walks performed within the past year. Another Moslem magician from India. Ahmed Hussain who had walked the fire on many occasions in India. was tested, together with several English volunteers, since Hussain claimed to be able to convey his alleged immunity from burn-

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ing to others. The Englishmen of the investigating Council evidently had deep-dyed designs for breaking up the foreign monopoly on fire-walking and planned to build up as early as possible a home industry. They had advertised for volunteers and 40 people volunteered to walk the fire. Those selected, presumably from ordinary walks of life, were Messrs Craigie, Marshall, Bould, Chesney, and Adcock, weighing respectively 143, 145, 124, 177, and 157 pounds. Hussain weighed 126 pounds

Professors C A. Pannett and W D Newcomb tested their fect for possible chemical treatment and washed them in cold water, drying them carefully Hussain had requested a trench 15 inches deep, four feet wide and 12½ feet long. This was provided and the fire was laid as before.

The surface temperature of the fire, taken by the physicists with a contact couple, was 575 degrees, centigrade, or 1067 degrees, Fahrenheit, and in the interior it was 700 degrees, centigrade, or 1292 degrees, Fahrenheit, as taken with a standard portable indicator lent by the Cambridge Scientific Instrument Company, Limited

Hussain, after reciting prayers from the koran, stepped into the fire and took three quick strides in 13 seconds (Frodsham stopwatch reading to one hundredth second) and was not burned.

Hussain had claimed that he could convey his immunity to others, so the experiment shown in one of the illustrations was made. Messrs, Craigie, Marshall, and Bould lined up behind him, holding hands, and the foremost clutching his belt. They crossed the trench in about 15 seconds. (What are the feelings of a novice as he is about to plant his naked foot for the first time on red-hot embers?) "All were burned to a varying, but slight, degree," the Report states, "but only one (to whose foot a piece of ash had adhered) complained of any feeling of pain."

Adcock then walked across alone, taking three steps in 14 seconds, followed by Chesney. "They were also slightly burned," the Report states, "and it was found that where the number of steps had been unver, the foot that had been down the more often was the more affected. This indicated that the injurious effect was cumulative."

Hussain then declared that he could walk any distance without being burned. He was therefore asked to walk continuously around the fire but discovered that he must always walk forward in a straight line!

On another day, the trench, now increased to 20 feet long and with the surface temperature of its fire 740 degrees, centigrade (1364 degrees, Fahrenheit), "Hussain, after muttering the usual prayers, crossed the trench in 2 3 seconds, taking six steps, and complained at once of being burned; he was found to have five blisters on one foot and marked crythema (reddening) on the other, a condition closely resembling that of the amateurs after four steps. He refused to walk again, attributing his failure to lack of faith."

Adcock then walked the trench, taking only four steps, and showed slight signs of burning. Later he crossed in dry rope-soled shoes, taking seven steps, and the soles were not burned at all. Bould and Russell next walked the trench and both were slightly burned.

One of the rope-soled shoes was then wetted and held in contact with the fire.

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This is an hypothetical algebraic oblong root, $\sqrt[4]{u^2-5u+6}=\sqrt[4]{(u-3)}$ (u-2) (u-3) or (u-2)

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LABORÁTORY SPECIALTIES, Inc. 132 South Watsch Street, Wabash, Indiana Several seconds elapsed before any sign of steam appeared, showing that the spheroidal state—the sudden formation of an insulating layer of vapor-does not occur under the conditions obtaining in the fire-walk.

It was very noticeable that the feet sank into the embers, the Report continues, to a depth of between two and three inches, so that the upper part of the feet were covered. It is very evident that the very low thermal conductivity of smouldering wood prevents damage to normal skin and other objects, if the time of contact is below about half a second and the number of consecutive contacts is not too great,

In a third and final experiment, with a nine-inch, twelve-foot trench, and a stiff breeze which raised the surface temperature of the fire to 800 degrees, centigrade, or 1372 degrees, Fahrenheit, Hussain crossed taking four steps and was uninjured. Then Reginald Adoock walked the trench in 1.8 seconds, taking three steps. He was not burned in any way and he made a statement that, no doubt, has immediate bearing on success in fire-walking, he said that former attempts had given him confidence to walk

The Report then shows a comparison that 14 of interest, since it makes clear that in three trials the English novice-an average man such as the present reader is likely to be-had easily equalled the Oriental "professionals" (Kuda Bux had stated that for several consecutive years he daily performed the feat at an annual religious festival which lasted a week). Kuda Bux, Hussain, and Adoock, weighing respectively 120, 126, and 160 pounds, walked distances of 11, 12, and 12 feet, taking 4, 4, and 3 steps, in 22, 16, and 1.8 seconds, in minimum time of contact per step of .55, .40, and 60 seconds, over surface temperatures of 806, 1472, and 1472 degrees, Fahrenheit "It will be seen," the Report points out, "that both Hussain and Adoock exaceded Kuda Bux's performance by walking on a fire of nearly twice the surface temperature. Further it is remarkable that Adcock should have survived, without injury to his feet, the greatest minimum mean time of contact."

What, then, in sum, is the secret of firewalking? Dr. G. Burniston Brown, the author of the Report, sums it up as follows (slightly condensed).

"The fire-walk is in no sense a trick; the walk is performed in the normal manner with bare and chemically unprepared feet.

"Owing to the fact that the surface of the fire is a very unstable one and the feet may sink in several inches, it is impossible to walk so that a constantly changing portion of the foot is in contact with the hot embers this would be possible on a firm plane surface) and skill of this kind is not a factor necessary for success. Nevertheless, steadiness in walking is an advantage in order to avoid remaining with the weight on one foot for too long an interval.

"Moisture on the feet is a disadvantage. "The spheroidal state does not occur.

"No abnormal degree of callosity of the feet is required.

"Fasting or other initial preparation is not necessary.

"No evidence was shown that immunity from burning can be conveyed to other persons.

"The fall in the temperature of the surface of the soles of the feet during the experiment was possibly due to a number of l



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steps being taken on the grass after leaving the fire, before the place of examination was reached.

"Immunity is not due to contact with layers of relatively cold ash in which combustion has ceased, since in experiments with Kiida Biix the ash was removed, and, in any case, the feet sink in sufficiently far to be in contact with the burning embers and small flames below the surface

The equivalence of the performance of one of the amateurs with that of the professional fire-walkers, and the small differ ence between their performance and that of the other amateurs (the professionals could not take more than two steps with each foot without injury), together with the fact that the immunity could not be transferred, indicates that the slight immunity shown is not sufficiently abnormal to require the hypothesis of a specially induced mental state, for example, 'faith' The fact that no signs of burning were found on the dry rope soled shoes (which can hardly be supposed to be affected by the mental state of the wearer) leads to the view that the secret of the fire-walk lies in the low thermal conductivity of the burning wood The thermal conductivity of copper. for example, is about 1000 times greater than that of oak wood

'In order that damage may be caused to the skin or other substance by contact with a hody hotter than itself, it is necessary that a certain quantity of heat should enter the colder body, and that the time during which this transfer takes place should not be too long, otherwise the heat may be conducted or radiated away before the temperature has risen sufficiently. Consequently, in spite of a large temperature difference such as exists in the fire-walk, the quantity of heat transferred may remain small if either the thermal conductivity is very low or the time of contact is very short. In the case of the hre-walk, burning wood and its ash are very poor conductors of heat, and, furthermore, the time of contact is not above about half a second in normal quick walking Even so, successive contacts of this period cause an accumulation of heat sufficient to cause injury, and the experiments have shown that with fires whose temperature is 500 degrees, centigrade, or more, only two such contacts can be made with each foot without erythema or blistering."

Dr. Brown, in clearing up lesser details, remarks that "it is to be expected that a people who normally walk with bare feet, especially on the hot ground in tropical countries, will exhibit a greater resistance to injury than the volunteers in the experiments in England, and hence it may occur that, in Indra for instance, the fire-walker's limited immunity is in no way unusual." He also alludes to the hypothesis of hypnotism and refers to some side experiments that were made at Maudsley Hill Mental Hospital showing that, although subjective feeling of pain may be considerably lessened by hypnotism, any inhibition of normal akin reactions to burning can be only slight. With regard to things of this kind, or to things physiological such as the possible power of inhibiting the activity of the sweat glands of the feet, it may be said simply that these crutches are not necessary, for the facts of a purely physical nature—namely, brief contact, few contacts and a poor conductor of heat seem sufficient to account for the ability to do fire-walking.

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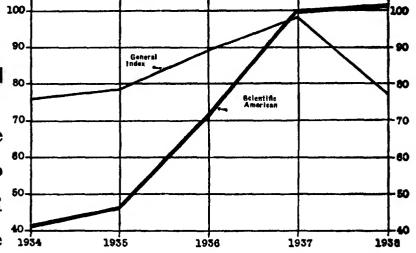
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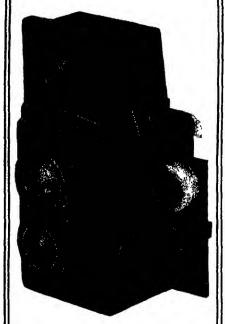
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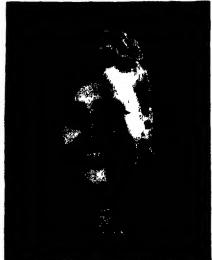
The plan finally approved was to set up a kind of "studio" in one of the rooms of

the house in which the affair was to be held A main light, diffused, was set up at the conventional 45 degrees in relation to the background and a spotlight was employed for an emphasis light. These were made ready before the guests arrived and a camera was set up on a tripod so that picture-making could commence with the least fuss and danger of possible interference. The camera used was a 9- by 12-cm filmpack-plate type, equipped with a telephoto lens of double normal focal length. The background consisted of drawn window curtains which were fuzzed out by the large diaphragm opening— $f_1/5$ 5. Subjects sat on a backless bench

The names of the victims were gathered









Party portraits with a purpose. These four are examples of the type of work that can be done rapidly if you follow the suggestions given in the note above

in advance, permitting a steady progression after picture-making began. For the sake of the sitter and to facilitate the making of pictures, the door of the "studio" was closed each time. This helped both the sitter and the photographer, and as a result matters went along very smoothly

While the lighting was, in the main, the same for all, the spotlight as well as the general illuminant had to be shifted occasionally to suit different personalities. Also, of course focusing was arranged for each individual in view of the shallow depth of the long-focus lens, but masmuch as the ground glass had to be inspected for subject composition answay, the frequent focusing was not undily bothersome.

Off-hand, it would seem that the best camera for the purpose would have been a minia ture and the pictures made one after another with hitle interruption between each one. But in view of the fact that the number of persons involved was not great and the desire of the photographer and the sponsors of the event was to give the best possible performance for the money, the larger camera was chosen and an attempt made to compose each picture carefully. Your money's worth, was the keynote of the interprise.

The price of one dollar for single portraits and one dollar and fifty cents for portraits of couples was found to receive practically universal acceptance. Out of a relatively small group, a total of 20 dollars was collected. Enlargements, a sample of which was shown to prospects before picture-making began, were made on 8- by 10-inch double weight stock, semi-matte surface.

In addition to the picture-making, three 11 by 14-inch enlargements of favorite negatives taken from the files were mounted on 16-by 20-inch exhibition mounts and sold by lottery

It is needless to say, of course, that the photographer engaged in such a strenuous venture as this may make up his mind that he will see practically nothing of the party!

LEICA IMPORT

DIFFICULTIES ordinarily encountered with U. S. Customs officials by Leica owners who want to bring their camera back into the United States upon returning from a trip abroad may now be avoided. An "Import Certificate" is being issued with each new Leica camera, lens, or Leitz hinocular which has been imported through regular channels. This consists of a small card on which is stamped essential identification information concerning the camera, and assurance that full duty has been paid on the particular camera.

SECRET CAMERA NOTE FROM ASIA

EWS of bustling activity in the manufacture of photographic equipment and materials in China and Japan has come to us by way of a friend of a friend who recently received a letter from Shanghai In part, this letter discloses:

"It may interest you to know that the Japanese are now making the most extensive photographic products imaginable. They include: films for Leica, the 'Canon'; an

amphibious Leica-Contax, called the 'Baika', Leica-type with 'Lausar' / 3.5 lens, 127 film size; and a score of 620 roll-film cameras with Japanese made Compur shutters and lenses. For the first time, a Chinese company is making cameras, box-type, lens ground in Shanghai first batch of 10,000 destined for India."

Making Pectures of the Picture Makers

TRAIN your camera on the camera shooters the next time you go strolling in search of picture material it's lots of fun. The important thing as in all candid shoot



Picturing a picture maker

ing, is to make suit you are not observed by the victim. This is comparatively simple ahe, or she, is probably so engrossed in focus ing and viewing his own subject that he or she pays little heed to anything else that may be going on around.

CONTESTS

NEWS of photographic contests comes to us this month from two fronts

Commemorating the 100th anniversary of the birth of photography, the manufacturers of Rolleiflex and Rolleicord cameras are sponsorrug the First International Rollei Competition, with prizes totaling 500 cash awards headed by a first prize of \$200 in addition, many of the winners will be represented in a Rollei picture book tentatively titled "The Magic of Light"

"Anything that makes a good picture' is the sponsors' only requirement, with "no restrictions as to subject or quantity of pictures to be entered." Artistic ment and general interest are to be the bases of judgment. Prints must be enlarged to at least 5 by 5 inches, though original color transparencies are acceptable. All entries must be mailed before August 31, 1939 and prizes will be announced December 1, 1939. American entries may be mailed to Burleigh Brooks, Inc., 127. West. 42nd. Street. New York, New York. Rules and entry blanks may be obtained from the latter or from the local Rollei dealer.

Increased prizes and decreased entry fees are the features of the Second Annual Competition in News and Pictorial Photography at Kent State University, Kent, Ohio, under the auspices of the Department of Journalism. The closing date for submission of entries is March 1, 1939. The prizes this year will consist of a first prize of \$40 and (Please turn to page 184)

WILLO JR. ENLARGING EASEL



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The judges—left to right: McClelland Barclay, Robert Yarnall Richie, and Ivan Dmitri—eliminating, in the semi-finals, pictures from this inating, of more than 100 which had of excellent group of more than 100 which had prints that were submitted in our photo contest prints that were submitted in our photo contest prints that were submitted in our photo contest.

1st PRIZE in Division 2, Landscapes. Entered by H. Lou Gibson, Rochester, New York. Taken with a Recomar camera on Eastman Panatomic film. No filter was employed

1st PRIZE in Division 3, Science and Industry, including Natural History. Photographed by Ruth M. E. Hennig, Boston, Massachusetts. This unusual bird photograph was taken with a Kodak on Eastman S. S. Pan film

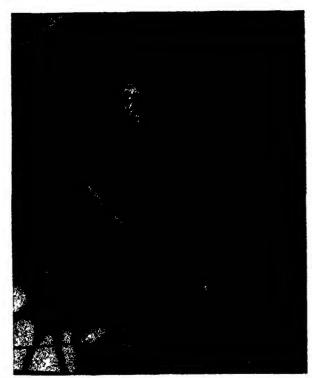
PRIZE WINNERS

IN THE

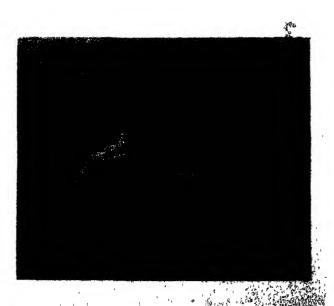
Third Annual

SCIENTIFIC AMERICAN

Photography Contest



1st PRIZE in Division 1, Human Interest. Submitted by Allen Brooks Howard, Jr., Staten Island, New York. This striking character study was taken with a Rolleicord camera, the exposure being made on Eastman S. S. Pan film



HONORABLE MENTION AWARDS DIVISION 1

William A. Baker, Quincy, Massachusetts Francis J. Wilson, Saskatoon, Saskatchewan, Canada Lau Wai Kwong, Hong Kong, China Carl Bakule, Minneapolis, Minnesota Mrs. Harry N. Aldrich, Chicago, Illinois

DIVISION 2

J. B. Gusa, Fort Lewia, Washington Georg Halasz, Budapest, Hungary G. L. Osmanson, Morris, Illinois Elise Voysey, Bayville, Long Island, New York H. Farkas, Budapest, Hungary

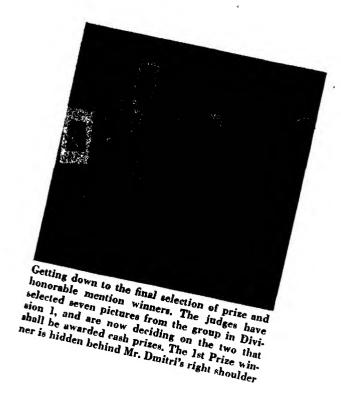
DIVISION 3

George F. Watson, Beloit, Wisconsin Thomas E. Benner, Urbana, Illinois Don Laskey, Grand Rapids, Michigan Anthony Pulitano, Brooklyn, New York Adolph W. Dreyer, St. Louis, Missouri



2nd PRIZE, Division 1. "Curly-Head" was submitted by Stephen F. Harris, Dover, Massachusetts. The picture was taken on Eastman S. S. Pan with an Auto-Graflex camera







2nd PRIZE, Division 2. Entered by E. Haeberle, Elmhurst, Long Island, New York. An unusually fine sunset, taken with a Rolleiflex camera on Agfa S. S. Panchromatic film

2nd PRIZE, Division 3. Taken by Kenneth Carlisle Marthey, Brooklyn, New York. The spirit of railroading was caught with a Rolleicord on Eastman S. S. Pan film



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x 21,") negatives, 31 " x 5" prints from 1 vestpocket and
Bantum size, and 21,2" x 31," prints from abile frame
35 mm negatives. Makes 5" x 7" prints from abile frame
35 mm negatives. Makes 5" x 7" prints from 21/4" x 34/4"
negatives and 5" x 53/4" prints from 21/4" x 21/4" negatives
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Kodex shutter
2% x 3½ Icarette 501 Tessar F/4 5, Comput pur
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F P A, 3 C F H
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F P A
9 x 12 Ihagee Duplex 13 5cm F/45 Tessar,
coupled tange hnder, case, F P A
Vollenda Radionar F/35 S
Welti F/2 8 Tessar,
Exakta A F/2 8 Tessar, case
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Tessar
Roth Flow F/2 8 20 00 45 00 40.00 50 00 22 50 37 50 40 00 40 00 Foth Flex F/3 5 Anastigmat, case 5 x 7 Piess Griffex F/4 5 Velostigmat, both Flex F/3 5 Anastigmat, case 5 x 7 Press (a iffex F/4 5 Velostigmat, F P A 4 x 5 RB Fele Graffex 21cm F/4 5 Tessat, F P A 3½ x 4½ RB Graffex Series D F/3 5 Tessat 10 5cm F P A Robot, F/2-8 Tessat, case 3½ x 4½ A Autographic Kodak Special F/6 3 Anist, Kodamatic shutter 1½ x 2½ Korelle P Radionat F/2-9 case, F P A rollnim holder 1½ x 4½ RB Graffex Series D 632" F/2-9 Pentae, case, F P A Exakta B F/2 Biotar 50 00 75 00 90 00 75 00 15 00 25 00 20 00 SEE YOUR PRINT **BEFORE YOU MAKE** IT WITH THE

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a second prize of \$10 in each of the two divisions. Judges of the news photography competition will be members of the program advisory committee for the Short Course, while Frank R. Frapric, F.R P.S., editor of American Photography, and members of his staff, will judge the pictorial division.

All newspaper workers and students and instructors in schools and departments of journalism are eligible to compete in the news section. The pictorial contest is open to everyone Entry fee in either section is \$1 for four prints or less, with a charge of 25 cents for each additional print

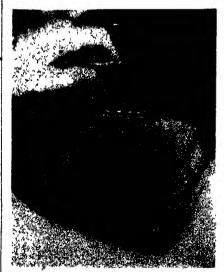
Rules include preference for 8 by 10 or 11 by 14 inch print sizes, and not smaller than 5 by 7 Regulation 16 by 20-inch mounts suggested, but larger or smaller mounts, if used effectively, will not be barred Name and address of photographer should appear on back of each print, accompanied by exposure data. If desired, name may be placed on front of print with title

FLASH AND FLOOD GUIDE

TOURS for the asking is a handy little Pocket guide containing a wealth of use ful exposure data on flash and flood pho tography just announced by the Wabash Photolamp Corporation, of Brooklyn, New York. This little pocket guide lists over 120 different films in 35 mm, cut- and rollfilm and film-pack, made by Agfa, Defender, DuPont, Eastman, Gevaert, Hammer, Ilford, Perutz, Univex, and other film manufac turers, together with data and exposure tables for correct use in making flash and flood pictures. Complete data and exposure tables are also included for the various 8-mm and 16-mm films for home movies, as well as tables for Kodachrome and Dufaycolor films. The Wabash people, as you know, make Superflash and Superflood bulbs,

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keeps the sponge always ready for use but it may thus be left moist. A viscose sponge protected in this way will always remain free of dirt and grit provided any dirt accumulated during use is immediately washed and the sponge squeezed of excess water, never wrung

TRAVELING CAMERA EXHIBIT

F you live in or near Philadelphia or F you live in or near rinner property or Reading, Pennsylvania; New Haven or Rhode Hartford, Connecticut, Providence, Rhode Island, Boston, Massachusetts, Syracuse, Rochester, or Buffalo, New York, you will soon have an opportunity of attending the Universal Camera Exhibit, which is taking to the road under the auspices of the Leica people Consisting of working set ups of specialized Leica camera accessories, such as the photomicrographic, photomacrographic, copying and reproduction devices, and so on, in addition to the complete line of Leica cameras and more than 500 accessories, the exhibit will be in charge of Anton F Baumann, Leica expert, lecturer, and photographer In addition, Mr Baumann will demonstrate his methods of making giant enlargements and will lecture on color photography

The exhibit will be on display for three days in each city from 1 to 10 PM Exact dates are available from local Leica dealers

IN Praise of the CHANGING BAG

DECENTIA we had occasion to use a R film changing bag under circumstances which did not easily permit the unloading and reloading of cut-film holders. Since we chiefly employ the miniature type of camera if shooting when away from the studio, the need of a changing bag does not often arise, but when it is needed, it plays its rôle ad mirably. A word of caution to those who are using the changing bag for the first time. Do not attempt to unload the holders and reload them during the same "session." Introduce a box and a protective opaque material such as black paper into the changing bag with the holders to be unloaded. Unload the holders, wrap the film with the opaque sheet of paper and place in the box, after tightly closing the box, end that particular chapter of the session. For reloading, return the empty holders to the bag, accompanied by a new box of cut film and load in com

WHY IS A PRIZE PICTURE?

WITH Norris W. Harkness, columnist for The Camera (Philadelphia) and Nature Magazine, we recently collaborated in the judging of photographic prints submitted in a club competition. We could select only two prints in each of three classes, a First Award and a Second Award

Those finally chosen were picked out because they were well or satisfactorily composed, the printing quality was good, the subject matter interesting. Those that fell by the wayside had in several instances sinned chiefly because they lacked but one of these three qualities. If the subject matter of one was good, it lost out because the negative was under- or over-printed; in another the printing was satisfactory but the

Bass Bargaingram

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in being broadminded, Just because you got good results from your old RR F:8 lens is no reason for depriving your 18 year old son from owning an F:2 camera with ell refinements including hot and cold running water. After all . . this is a different age . . and RR (Railroad) lenses went out with clincher tires. The young fellows like to buy here because we ARE so liberal-minded Charles Pass

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10 x 15 cm R B Zeiss Tropical favorite Teakwood, double extension, Carl Zeiss Dominar F 4 5 Compur, film adapter and double holder, new list \$225 at \$73 60

There's romance and glamour in photographic equip-ment he it a camera or just another gadget keeps us hustling to keep shreast of things which explains why we have to keep on issuing new

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type negative carrier 2 metal masks—2
diameters With F 4 5 ansatigmat



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So You Want to Take BETTER PICTURES

By A. P. PECK

Associate Editor Scientific American

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LONG experience as an amateur photographer himself, and constant contact with other amateurs who are eager to learn, have enabled the author to anticipate your questions, to put the fundamentals of photography on such a basis that they can easily be absorbed.

THE next best thing to a face-to-face chat with one who has been through the mill and has learned by experience is to have at hand a copy of this book. You will read it first as an enjoyable, running story of what you can do with your camera; you will keep it always at hand for reference and help.

SOME of the phases of photography that are covered: Your Camera and How It Works; Lens Speeds and What They Mean; Exposure; Lighting Indoors and Out; Portraits; Landscapes; Tricks With Your Camera; Action Pictures; Your Pictures Can Be Enlarged; Equipment; and many others.

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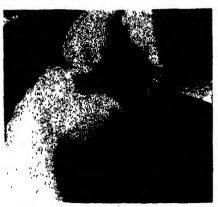
New York, N. Y.

picture content was presented without imagmation. One fault that was particularly noticeable was the evident misunderstanding of the type of picture suitable for submission in a competition of this sort. For example, a dish of fruit that was remarkably well printed had to be discarded because of the commercial type of lighting employed in making the picture: an even light from both sides. Another picture of this type was one showing a bowl of flowers on a table and a woman's hands engaged in arranging them.

A prize picture, therefore, would seem to be that one which possesses all those good qualities which combine to make the print that stands above the crowd. Interesting subject-matter probably comes first, followed by proper selection of viewpoint and good composition, selection of the proper paper contrast for the negative employed and a printing depth sufficient to record the tones of the negative within the capacity of the paper. One careful worker has made it a rule never to enter the dark-room with more than one negative and to work with that negative for all it was worth. Sounds worth while,

THE BELLOWS MAKER

To those in the know, bellows-making is considered one of the most skilful of the arts dealing with the manufacture of photographic equipment. The illustration shows



Bellows making

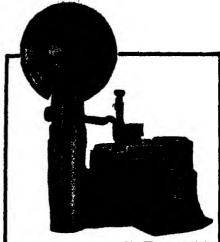
the method by which the bellows are folded in the familiar "accordion" fashion. The hands you see were taught their cunning by a master in the craft as they, in turn, will demonstrate the art to another in the future.

TREATISE ON EXPOSURE

A COMPREHENSIVE and rather extensive treatment on the subject of exposure, exposure meters, and their proper usage, discussion of the meaning and importance of the various film-speed rating systems now in use, plus much other useful information on the subject, is now under way. The guide, as it is intended to be, accompanied by a compilation of the latest film-speed ratings for the various emulaisms now available, is being compiled under the direction of Joseph M. Bing, F.R.P.S.

STRAIGHTENING PRINTS

M ANY workers experience difficulty in flattening out prints after they have dried. The knack of straightening points at



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the method of passing the backs of the prints over the table edge or under a rule, is not always successfully employed, sometimes resulting in unpleasant cracking. One very effective method is to moisten the backs of the dried prints with cotton, cloth, or a sponge, insert the prints between blotters either in a print press or under a weight, such as a number of books, and leave them overnight. The next morning the prints will be found to be perfectly flat, and will stay

VARIABLE DIFFUSION SCREEN

OUR different diffusion degrees are possible with the home-made diffuser shown in the illustration The device consists of a pair of knitting or embroidery hoops, four



Diffusion screen

pieces of cheese cloth and a bit of scotch tape to hold the ends of the cloth to one of the hoops. In use, a piece of cloth is inserted in the hoop, while the others hang free out of the way For greater diffusion, more of the cloths are added

SUCCESS WITH THE WIRE FINDER

COME camera users appear to have diffi-O culty in employing the wire or frame finder on their cameras. They complain that the picture they get is different from the one they saw in the finder The fault probably hes in the method of using the finder. This finder is accurate for all practical purposes if the eye is held close to the small opening at the back of the finder and an effort is made to see the outline of the frame and to enclose the view within this outline. Unless these two precautions are observed, the picture will differ from the view

SEE YOURSELF AS THE CAMERA SEES YOU

LACING a large mirror behind the camera to permit the sitter to see him or herself approximately as the cameraman has arranged matters on the ground-glass or in the view finder, has been suggested as a possible aid in making portraits. The contention seems to be that if the sitter can see himself in the mirror, he has a feeling that he is taking a real part in the actual making of the picture and can more easily assume a natural pose and expression. Since the suggestion was made by several persons independently of each other, perhaps there is something to it after all. At least, there is no harm in trying it.



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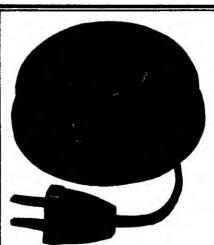
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nation for contact printing papers. With red filter may be used for orthochromatic films, with panchromatic, except those requiring development in total darkness, yellow bulb and green filter are used Lamp fits any standard electric outlet

ZENOPRINT KIT (\$100) Contains materials for making contact prints without use of dark-room. Process utilizes newly introduced Safelyte Paper, with orange repellent dye Dye disappears in fixing bath, leaving ordinary black and white print Kit includes, besides paper, special developer containing red light-repellent dye, standard hypo solu-tion and special flexible printing frame. In operation negative and paper are placed in frame, latter bent for perfect contact, in front of ordinary electric light bulb and exposure of several seconds is given, followed by development and fixing in the usual way Additional supplies of paper may be purchased separately, sizes ranging from 2% by 41/2 inches to 5 by 7 inches

IMPERIAL PRECISION FASTI (\$9.95) Allmetal, plan-parallel paper surface, sil ver-blast focusing surface Margin masks, with controls at both ends, and adjustable white horder control for squaring up paper with casel and masking bands and giving measured white border to prints. Makes up. to full 11 by 14-inch prints

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per Strips supplied with box permit separating different contrasts or types of paper Type now available for 8 by 10 paper can be used for smaller sizes. Larger sizes will follow later.

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INFRA-RED PHOTOGRAPHY, by S. O. Rawlings. A treatise on the use of photographic plates and films sensitive to infra-red. Exposure and processing are fully covered; formulas are given for sensitizing, \$1.65.

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CAMERA LENSES, by Arthur W. Lockett. Explains simply and clearly, yet with scientific accuracy, all the underlying principles of lenses. \$1.10.

CHAMPLIN ON FINE GRAIN, by Harry (hamplin, A complete hand-book on the entire subject of fine grain, in-cluding formulas and how to compound and use them. \$1.90.

PHOTOGRAPHIC HINTS AND GADGETS, by Francie and Jordan, How to make all kinds of photographic accessories; from film clips to cameras to light-ing equipment, and so on; 250 articles and nearly 500 illustrations. \$3.70.

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PHOTOGRAPHIC ENLARGING, by Frank-lin I. Jordan, F. R P. S. One of the most interesting and authentic books on enlarging. Its 224 pages cover every phase of the subject and 75 illustrations, many of them salon-winners, show the value of correct technique. \$3.70.

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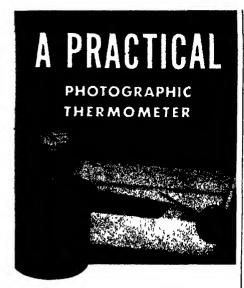
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JACOB DESCHIN, conductor of our "Camera Angles" department, will answer in these columns questions of general interest to amateur photographers If an answer is desired by mail, enclose a stamped, addressed envelope Queries should be specific, but Mr. Deschin cannot undertake to draw comparisons between manufactured products nor to advise on the purchase of equipment or materials.-The Editor.

Q. What are the advantages and disadvantages of hypersensitizing film in order to increase its speed?-J. C.

4. The fact made public by Agfa Ansco Research Laboratories that film emulsion subjected to the action of mercury vapor can be increased in sensitivity from 50 to as high as 150 percent of the original speed, is obviously a boon where great film sensitivity is required. This is the great advantage of the process. Another is the fact that if a roll of film is known to have been underexposed, the hypersensitizing treatment can be applied after exposure to "add" the required speed up to as much as 100 percent or double the speed of the film when exposed Also, the maximum effect of the process is obtained by treatment both before and after exposure of the film, bringing additional speed up to 150 percent. The disadvantages, if so they may be called, include the length of the hypersensitizing period, 30 hours for loosely rolled, uncovered film, and from 6 to 8 days for paper backed spools or 35-mm magazines, and that if there is too great a lapse of time (three to four weeks) between the completion of hypersensitization and actual exposure of the film, the added speed wears off

Q. Our high school is planning to purchase a camera suitable for taking all pictures needed in their year book. We take most of the pictures indoors. The camera should be one that will take both group pictures and portraits. I should appreciate it if you would give the approximate cost of such a camera and the names and addresses of dealers handling these cameras.—R. F.

A. A proper reply to your inquiry can be made only with a knowledge of several factors not included in your inquiry; namely, the amount of money you are willing to spend on this equipment, the size negative you desire and whether you wish to print by contact from relatively large negatives or to make enlargements from smaller negatives. In the latter case, of course, you will require an enlarger unless you intend to have the processing done by a photo finisher. Quite a number of camera types are suited to the sort of work you have in mind, from the 35-mm miniature up to the professional 8 by 10. Generally speaking, for group and

single portraits, a view camera affording negatives 4 by 5 or 5 by 7 inches, or a filmpack camera exposing negatives 31/4 by 41/4 or 4 by 5 inches, either camera equipped with a lens of at least f'45 maximum aperture, should be most suitable and least expensive for the kind of work you indicate We are assuming that the negatives are to be printed by contact. We refer you to the advertising columns of this magazine for dealers who handle various types of camera-

Q. When using glossy bromide paper, I find it has a bad curling tendency which makes it difficult, after exposure, to immerse it properly in the developing solution; that is, to insure the developer covering the paper evenly to the edges from the start. Can you suggest how the paper may be straightened to avoid this inconvenience?-D. C. K.

A. One of the surest ways, of course, 14 to make up a generous volume of developer solution (which is rather wasteful), so that even if the edges of the paper do curl considerably they will be submerged by the depth of the bath, aided by quick manual immersion. The problem is to flatten out the paper before the developer has a chance to do its work. What's wrong with immersing the exposed paper in a tray of plain water and when the paper has become watersouked and, as a consequence, straightened out, shipping it into the developer? Make sure, of course, to drain the excess water from the paper as thoroughly as possible, before immersion in the developer, to prevent undue dilution of the latter.

Q. In copying articles from journals I have used contact paper to make a negative from which I make a copy of the article which I want to keep. In making my negative I place a piece of sensitive paper (Velox No. 5 single weight) sensitive side toward the printed matter and have the light pass through the sensitive paper; thus the black of the printed matter absorbs the light and the paper remains light on being developed. Where there is no printed matter the light is reflected and the sensitive paper becomes black when developed. Is single weight the thinnest

paper available, as the paper I now use is bulky to go into files? Is there a sensitive paper made which will fold without cracking, which I can use for this purpose?—W. A. R.

A. Papers of the folding-without-cracking, thinner-than-single-weight type are Eastman's Solar Bromide or Line Solar Bromide (for contact printing), with dead matte surface; and Agfa's Nokoline and Defender's Document, both the latter in semi-matte surface. We notice that the sample print which you sent with your letter is on glossy, single weight paper, ferrotyped Unless you have a special reason for using a glossy paper, you will find the matte and semimatte papers more suitable and possibly easier to read Besides, these are the only surfaces in which the paper you prescribe is available. We observe in your print, also, numerous out-of-focus areas which were probably caused by improper contact between the magazine page and the "negative" paper. We would suggest the use of glass to hold paper and subject in contact and weights or pressure of some sort on all four sides, in addition to a flat surface on which to rest the magazine. Since you appear to be doing copying by this method right along, we believe you would find it advantageous to construct a printing frame of the conventional type but with an opening at the side for the pages on the other half of the bind ing as well as the bulky and interfering

Q. Enclosed are three photographs taken with a photoflash bulb at f/11, bulb exposure, and all taken within a few minutes apart. You will note that in one print the candles are correctly registered and on the other two there appear streaks as though the candles were blazing away but the effect does not register as coming from the candles; in fact it looks as though there were more than the actual number of four. The candles were just lighted and were burning very low. The suggestion that the camera was moved during exposure does not seem to fit the occasion as the other objects are all sharp. Can you offer any explanation?-F. K.

A. From the streaky appearance of the flames and the fact that the flames seem to be "disengaged" from the candles themselves, our guess is that you held the camera in the hand, using an ordinary hand flash The shutter being open for some time before you actually set off the flash, the candle flames were registered on the film and since you moved the camera, this registration appears as a streak. The other objects, as you kay, are all sharp because the only illumination they had was that of the flash.

Q. Can you suggest a suitable material other than galvanized iron with which to line a dark-room sink?-P. R. F.

A. Several workers we know have had minently good success with sheet lead for this purpose. This material being practically mert to acids, other than turning black where the acid is spilled upon it accidentally, no protective coating is required as in the case of such metals as galvanized iron. Lead lining is easily worked because it is relatively soft. However, because of the hazard of cutting holes in it by accidental dropping of sharp or hard objects, some consider the material to be unsuitable for the purpose. On the other hand, since most sinks of the dark-room type are usually provided with wooden racks upon which trays are rested, the danger mentioned is largely minimized. A suitable thickness for darkroom sink lining is 1/32nd of an inch.

Q. I am considering the purchase of an enlarger for my camera and would appreciate it if you could give me some information as to where, what, and the prices of some enlargers. My camera takes a 21/2 by 41/4 negative, and I would like to have an enlarger to take this and smaller, if possible.-R. J. C.

A. We do not know of any enlarger specifically designed to take the negative size accommodated by your camera. In selecting an enlarger, therefore, it will be necessary for you to make a compromise and to pur chase an enlarger taking negatives up to the longest dimension of the negative made by your camera, which would mean a short dimension of 314 inches In that case, of course, you will need a special mask for your negatives Since 21/2 by 41/4 inches is a rather odd size these days, you may find that in enlarging you habitually crop a portion of the long side anyway. If that is the case, perhaps an enlarger of the 21/4 by 31/4 or 212 by 31/2 such size might do. This is not an unreasonable assumption, by the way, witness the numerous instances in which the popular 21/4 by 21/4-inch negatives are cnlarged, not square, but to a vertical or horizontal rectangle. Any of the photographic supply houses whose advertisements appear in our columns will be glad to furnish literature and prices on request,

Q. In ordering from a glass company a large sheet of photographic ground glass for a special purpose I have in mind, how shall I specify my requirements?-L. A. S.

A Ground glass is prepared in several grades of fineness; the finer it is, the more expensive. For best results, when used for photographic purposes, it is necessary to specify "mudground" glass. This is the most expensive and is not kept in stock but must be prepared on special order, except in the

ordinary sizes used in conventional cameras.

However, it is well worth the extra cost.

Q. In taking pictures of small animals and birds by remote control or otherwise on the sly, I find that the subject is frightened away after the first shot. It seems that the noise caused by the reflex mirror flying up against the ground glass is a little too much for them. Is there any way I can muffle this noise?-C. S. K.

A. You probably know that an eveready leather case, with its felt lining, is fairly effective in softening the noise to a moderate extent. But if you do considerable work along these lines, we would suggest a device something on the following order: Construct a box just big enough to take your camera, and line the box well with some noise-absorbing material. Provide openings for the lens and the cable release, making your focusing arrangements in advance. Of course, the design should also include some such arrangement as hinged doors to provide for inserting and removing the camera.

Half THE PRIZES WENT TO ROLLEI CAMERA OWNERS!



As you may have noticed on pages 182 and 183, just half of the six cash prizes in Scientific American's Third Annual Contest were awarded to Roller pictures Considering the fact that scores of different cameras were used by the contestants, these figures are very significant Let's analyze the awards

1st Prize in Group I (Portraits) was given to a picture made with a Rolleicord.

2nd Prize in Group II (Landscapes) awarded to a picture made with a Rolleiflex

2nd Prize in Group III (Natural History) was made with a Rollelcord.

Of the 15 pictures awarded Honorable Mention four were made with Rolleicords-and two with the Dolling (another camera distributed by Burleigh Brooks, Inc.)

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BURLEIGH BROOKS

A Monthly Department for the Amateur Telescope Maker Conducted by ALBERT G. INGALLS

CONTRARY to the kind of opinion that might be offered by the average person having no background about telescopes, if you wanted to design the one single telescope that would make visible at one single view the greatest number of stars, you would not employ high magnification but low

Taking several governing data as the basis of the design, it is possible to figure out the exact characteristics of such a telescope, and this is just what one of the authors of "Amatein Telescope Making Advanced, the companion volume to the beginner's book "Amateur Telescope Making," has done in that book. This telescope is named the "RFT," or "Richest Field Telescope."

The beginner usually tends to crave high magnification and, when the RFT with its low magnification was first described some amateurs his itated to make it, knowing perhaps that their neighbors and friends would rate them low when they heard the answer to the inevitable question, "How much does it magnify?" However, the RFT, magnifying 15 or so diameters, becomes popular and is used usually as an adjunct to the regular" Newtonian magnifying 50 to 100 diameters its complement in fact.

S. I. Walkden, of London, has described here in previous numbers several modifications of the RFT, and now comes his Herschchan RFT. The Herschehan type of telescope has had a bad reputation, perhaps it can partly reform. Walkden writes.

"Regarding RFT's These instruments need not be of only the refractor and Newtonian types, there is another class of instrument, the Herschelian reflector, which very much claims attention. It does so chiefly on account of its brilliancy, due to the absence of losses of light by flat obstruction and by flat reflection. In the small sizes it is nearly as brilliant as a refractor, and in large sizes more brilliant. Because it needs only a mirfor and excusere its construction is easy and is further made casy, compared with the Newtonian, because the mirrors of long focus have only shallow spherical curves to be ground, and need not be parabolized like the deep, short focus mirrors and mirrors made for high magnifications. Of course, the notable weakness of the Herschehan has always been its defective definition, due to the oblique view and the use of ordinary astronomical magnifying powers, but that can be minimized by giving the mirror a proper focal length. Then, with the very lowest possible powers (which are precisely those of the RFT's, only 35 per inch of aperture). the defect in definition-an occasional trace of cocked-hat shape in the star imagesmust, in many opinions, be considered sufficiently unobtrusive

"In Figure 1, a graph of focal lengths for different apertures, a curve marked GDH (standing for "good definition Herschelian") tells the focal length considered necessary for good definition, because it makes the oblique angle, like α , or EJX in the corner squat diagram of Figure 2, not more than

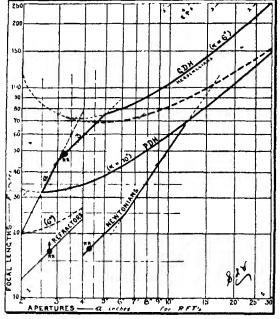


Figure 1: Design data

about 6° This angle has been judged in tests to be the best criterion of definition. [The squat diagram is not to scale

Fd 1 The formula used for the curve in Figure 1 is F= $(7.5a^2 + 15a) / (a - 1.5)$, but the curve, read to within a few inches, serves as well as the formula If with this focal length the instrument is thought too long to manage, less focal length can be used-with less, however, to be expected in the way of definition; but less length than the PDH (poorer-definition Herachelian) curve of the same figure is not recommended. The formula for that curve is F= $(4.5a^3 + 9a)/(a - 0.9)$, allowing the oblique angle α to be as great as about 10°.

"From 5" down to 3" aperture, the upper limit of focal length is at the thick straight line marked 3, unless an eyepiece wider than about 3" is not minded. From 3" down to 2½" aperture the upper limit of focal length is at the thick straight line marked a—unless an eyepiece wider than the aperture is not minded! Actually, at less than 4" aperture, and certainly at less than 3" aperture, the refractor, for

which focal lengths are also indicated, is the preferable type of RFT. For it, F=6a is assumed, but $F=5a^2/(a-1)$, shown in the 6° dotted curve, may help the realization of finer definition in these small instruments. Newtonians of greater than 4° aperture are rivals both for shortness and definition, but fade out in both these advantages at over 10° to 15° aperture, and of course are harder to construct

"When the F inches of focal length of the Herschelian of a inches aperture is settled, the focal ratio $c=\Gamma$ a and the width EK across the top of the instrument (see the squat diagram) may be calculated as 0.3c + a + 3 inches. The top diameter of the main tube at the focal distance, or diameter ∂K , is then $a+\phi 5$ inches, and the diameter of the focal image, EL, is c 5 inches. The mirror has to be tilted toward the little cross, midway between the points A and B, which points are at the centers of the main tube and the eyepicce tube. The distance AD, which will be found 3" after using the above rules, allows room for the side of the observer's head, as he observes with his back to the sky and with the starlight coming into the main tube over his shoulder

"The three black dots of Figure 1 are for general purpose RFPs of the different types of telescope

"The eyepiece is to be calculated by the simple rules already given in 'ATMA' for the other RFT's of the same aperture and

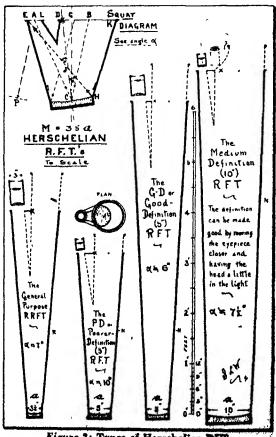


Figure 2: Types of Herschelian RFT

IN WILLIAM (THE

focal length. The little diagonal lines at the very top of Figure 1 indicate some eyepiece sizes, the abbreviation 'e.p.s.' meaning, as will be quite obvious, eyepiece size. For similarly good definition all over the field the eyepiece really needs directing at a point about half way from C to P (equat diagram) but its best direction is easily found on test.

"It is a good plan to give a Herschelian, especially a large one, a focal length according to the heavy dashed curve for medium definition (drawn freehand in Figure 1, not calculated, but formula is $F=(5a^2+15a)/$ (a-2) inches); as, for example, like the 10" instrument illustrated in Figure 2; and then, if the definition is not quite all that is wanted, move the eyepiece closer, so that the head intercepts a little light. The better definition may be considered ample compensation for the little loss of light not exceeding, perhaps, 10 percent. In larger and larger instruments, more and more of the observer may in this way intrude into the main tube till, at some aperture, perhaps about 100", the observer may entirely enter the tube. After that he may go to the center, to observe from there, just as already planned for the 200", and then have no obliquity of view to cause loss of definition.

"The two 5" RFT's illustrated in Figure 2 show how small instruments of identical aperture compare in length and size of eyepiece, one telescope made according to the GDH curve and the other according to the PDH curve. The 31/4" represents the important little general-purpose Herschelian RRFT-superior, at least in illumination, to the Newtonian general-purpose RRFT. It is not according to the GDH curve, but it cannot be made longer without becoming unwieldy and requiring a dreadfully large eyepiece A small number may prefer this lerschelian to a refractor of half its length, on account of the comfortable downward wew, and some may like to bring the eyepiece closer to the main tube, even though the head does then intercept a little light. One idea for keeping the head out of the light when the eyepiece is thus put closer, is to incorporate with the eyepiece a compound achromatic prism, bending the light outward through about a dozen degrees and itself absorbing very little light. Some such prism can be balsamed to the eyepiece lens. A more drastic plan is to use a total-reflection rightangled prism or a diagonal, but that may have more drawbacks; besides, it half turns the instrument back into a Newtonian, although one superior in illumination. There is much scope here for experimentalists to find the arrangements they prefer.

"Shorter Herschelians of good definition may possibly be made by those who specially figure the mirrors, but since parabolization has apparently to be done eccentrically, with reference to an axis nearer AP than to XC (in the squat diagram), only the heroic few, like the makers of Schmidt cameras, may ever attempt that figuring-or perhaps devise ingenious correcting plates.

"So long as the insides of the instruments are of the shapes indicated, allowing free passage for the light, the outside shapes may of course be different, according to fancy or convenience. In the limit nothing is absolutely necessary, except a heam or structure rigidly holding the mirror and the eyepiece in their proper relationship, but it seems better to have something like a tube.

"This is written with the awareness that there are some who can never be indulgent

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the merrier. Then the star images will not

dance about whenever a breeze blows or

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in a telescope made at a cost of \$11.60 by

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Philadelphia, Pa It has a 6" mirror and,

though the mounting is wood (white pine,

cypress, and even hemlock), this mounting

doubtless is very much steadier. One of the

telescopes originally made in 1920, at Spring-

held, Vermont, by a member of the Tele-

scope Makers of Springfield, was of wood -

pedestal, mounting, even the axes-and it

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heavy enough is to design it as would seem

to be correct and then double the dimen-

someone approaches.

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THE BEGINNER'S CORNER

ACTHOUGH "ATM" emphasizes the desirability of mountings that are rugged and heavy—what the machine designer calls "brutal"—a percentage of beginners build telescopes that are far too lightly mounted. Without wishing in any way to reflect on those who built the first three telescopes shown below—for they by now have doubtless sensed the fault if fault it be -these photographs are reproduced in a group in order to re-emphasize this point In every case, it will be noted, the telescope itself is excellent, and it is only the mounting, or parts of it, which seem light In each instance the tubing employed might to good







Was a success.

sions of the axes



TELESCOPTICS

(Continued from preceding page)

toward the definition of a telescope, and who would want to boil in oil one who persuaded them to make a Herschelian, but many more will consider they have found the very thing for brilliantly joy-riding with low powers around the glorious celestial scenery of the Milky Way. The first kind are recommended to solace themselves by converting their instruments to high power Newtonians, for the more sober joys of planetary and double star observation, for which purpose the long focus mirrors are very suitable."

IN advance of publication of the above has come a testimonial on the Herschelian RFT, part of a letter from Clyde W. Tombaugh of Lowell Observatory—the amateur telescope maker who discovered the first tangible evidence of the planet Pluto He writes

"Some time ago, Mr Walkden suggested to me that I try out my f/15 long-focus 5" reflector [the one shown in 'ATMA' at page 639 Ed 1 in Herschelian form as an RFT So I remounted the mirror on a wooden beam, offsetting the incident pencil 21/2" from the principal axis on one side and the center of the eyepiece 214" on the opposite side, and used an eyepiece of 31/2" eff and 13," field lens diameter. This gives 33X--still too high. Nevertheless, the star clouds and dark holes in Cygnus, Sagittarius, and so on were very beautiful. The definition is good over the whole field, 75' of arc in diameter. The off-axis effect is only slightly noticeable on the far side of the field."

Tombaugh adds that his eyepiece was a 45-cent, mail-order catalog 3X hand magnifier 1½" in net aperture, plus a simple lens of 2" fl taken from another eyepiece, the two separated 2 43" as a compromise on field and power This gave an e.f.l. of 2.3". As no out-size eyepieces, like some of those shown by Walkden, are known to be purchasable.

the amother may have to design his own, in the meantime possibly experimenting with some simple makeshift like Tombaugh's For a 3" (focal length) eyepiece, Walkden offers the following specifications f.l. of each lens, 4", Distance of lenses apart, 2.67" Diameter of field lens, 2.31", of eye lens, 1.31".

IN a private communication bearing on the Herschelian RFT, Walkden remarks that "perhaps some of the detail improvers will now get to work on special figurings of the RFT, eccentric and the like, to equip it for high-power magnification and a little lesslength" Well, that is just what two American amateurs have been doing already—making an offside paraboloid. But we'll tell about this in a later number

THE telescope snown in 11800.

4" / 5 RFT, ordinary Newtonian type,

17 Monle St., Saugus, made by R. B. Rice, 17 Maple St., Saugus, Mass, who says "the results with this telescope are very fine" But when it comes to enthusing over the RFT, as many have, George E. Dunn, 6906 Bingham Ave, Dearborn, Mich, whose 8" f/15 RFT is shown at the left in Figure 4, says. "Mine was disappointing at first and continued to be so until perfect optical line-up was attained. Everest's 'diagonalology' published in your September 1938 number, brings out this matter but it cannot be stressed too strongly for these short focus telescopes. I found it necessary to redesign the diagonal holder to get closer adjustment and more rigid construction before calling it a job. Even then it was not particularly impressive until one night when it was chucked into the rear of the car and taken into the country. That was my first view of the heavens away from the city haze. My vocabulary does not include much in the way of poetic expression, but no one can describe those clouds in Cygnus as seen through an RFT. This goes also for the double cluster near Perseus and count-



Figure 3: Rice and his RFT

less other regions. Diffraction effects are bad when first or second magnitude stars are viewed, and the RFT is useless on planets. On the other hand it out-performs anything I have looked through for terrestrial work

NO sooner does the telescope owner begin studying the Moon's map than his curiosity is aroused by the odd names given its formations, mostly names of persons "Who's Who in the Moon" is a newly published, 130-page memoir of the British Astronomical Association in which these names are explained-some 600 of them-and their owners' personal histories told

TIME budget of the average TN, as worked out by a telescope widow, Mrs. Howard Morchouse, Dearborn, Mich, asisted by a very accurate stopwatch and two checkers

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I NNOCENT literary agent in New York asks "Would you people be interested in an article on 'How to Make a Telescope' "? an article on 'How to Make a Telescope'

MISSEGRAIN is what S. 5. Weisiger, one of the Pittsburgh amateurs, calls a Cassegrain, no doubt after collimating one.

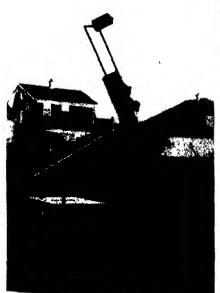


Figure 4: Dunn's two telescopes

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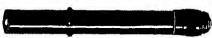
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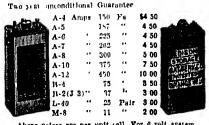
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(See Digest Section, Page (72)



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A MIRACLE BEGINS, by Dr. W. R. G. Baker, is an eight-page pamphlet that gives the straight facts about television-unsolved problems, programs, consumer problems, size of pictures, cost, and future prospects. General Electric Company, 570 Lexington Avenue, New York, New York, -- Gratis

VOIGHTLANDER EXPOSERS CALCULATOR 19 8 pocket-size chart of the "slide-rule" type which is adaptable to all parts of the world, all light conditions, and all film-speed ratings Willoughbys, 110 West 32nd Street, New York, New York -15 cents

PROTECTING PURITY CONCIDENCE IN PERIOD. ICAL ADVIRTISING IS a 16 page booklet that tells of the work which is being done to insure that the advertising columns of periodicals be kept free from objectionable copy It is of particular interest to executives and department heads in all concerns which use any form of periodical advertising National Better Business Bureau, Inc., 405 Lexington Avenue, New York, New York ---Gratis, as long as supply lasts

INDUSTRIAL PRICE POLICIES IS a 32-page booklet based upon a research study made by the Brookings Institution, answering such questions as "What would lower prices mean to business?—to profits? How are prices set in our modern industrial system? How can they be reduced without loss to stockholders or workers? What can the industrial executive do about prices?" Public Affairs Pamphlet No 23 Public Affairs Committee, Inc., 8 West 40th Street, New York, New York -10 cents

HATCH-O DATE is a chart designed to be used by poultry raisers and is especially helpful when several hatches of eggs are placed in the incubator at different times The chart is designed for eggs having 21 day incubation, but a correction table is furnished for other eggs. The chart includes a monthly calendar. Pope Brooks Foundation, Inc , Aton, Conn -10 cents.

LIGHTNIN PORTABLE MIXIRS is a lavishly illustrated eight-page pamphlet that shows various types of gear-driven and direct drive mixers for use in many process industries where small or large scale mixing of batches is a regular part of the procedure. The mixers described are adaptable to use in all types of tanks and cookers. Mixing Equipment Company, Inc., Rochester, New York --- Gratis

VISCOSITY TUBES IS an eight-page pamphlet which describes the air bubble method for determining the viscosity or body of varnishes and lacquers, as well as the equipment necessary for this test. Also listed are a number of other devices of interest to

chemists in general as well as to paint and varnish workers. R. P. Cargille. 118 Liberty Street, New York, New York.-Gratis.

Tego-Bonded Construction is a 32-page illustrated booklet which describes a modern method of producing plywood and related materials. This type of construction offers the user a panel that is durable, economical, and of practical utility. The method is based on a hot-bonding process wherein the component layers are permanently fused together with dry sheets of a synthetic resin The manufacture of the panels is described, as are also many of the uses which it finds in diversified fields. The Resinous Products & Chemical Co., Inc., 222 West Washington Square, Philadelphia, Pennsylvania. - Gratis

THE RAH WAY HANDBOOK, 1938-1939, is a paper-covered book which is designed to provide students and other interested parties with a collection of useful statistics and information, particularly regarding the railroads of Great Britain and Ireland A numher of the tables give international comparisons. In the statement regarding the electrification of steam railways it was deemed necessary to cover the whole world in order to present a complete picture of this increasingly important development Of wide general interest is a ten-page chronology of railroad history. The Railway Magazine, 33 Tothill Street, Westminster, London, S. W. 1, England 2 shillings and Stypence

HANDLE THE LLICA IS a small booklet that is essentially a straightforward sales talk for one particular type of miniature camera, but it contains considerable information which will be of value to any amateur photographer. Request Pamphlet No. 7784 E Leitz, Inc., 730 Fifth Avenue, New York, New York -Gratis

THE TIME LAG IN GAS-FILLED PHOTO-HICTRIC CITIS, by A.M. Skellett, is a 10page pamphlet, illustrated, which describes time lag measurements as made with a light chopper on a gas-filled cell of special design Bell Telephone Laboratories, 463 West Street, New York City.-Limited free distribution

WIRE ROPE FOR MINING AND CONTRACTING is a 96 page catalog which contains not only the usual price list but also has many pages of data as to stresses in suspended cables, stresses in hoist and incline ropes. and specific recommendations as to grades and constructions of rope for various types of power shovels, cranes, and other equipment; as well as a paragraph on the causes necessitating the premature discard of rope. Broderick & Bascom Rope Company, 4203 North Union Boulevard, St. Louis, Missouri. -Gratis.

TELEVISION RECEIVERS FOR THE HOME is an illustrated catalogue which describes a table and a console model television receiver. both of which provide a full 8 by 10 inch screen image as well as synchronized sound for complete sight-and-sound radio programs, Allen B. DuMont Labs., Inc., 2 Main Avenue, Passaic, New Jersey.-Gratis.

LEGAL HIGH-LIGHTS

Patent, Trade Mark, and Related Legal Proceedings That May Have a Direct Effect on Your Business

By ORSON D. MUNN, Litt, B., LL.B., Sc.D.

New York Bar Editor, Scientific American

ICE HOCKEY

A CASE packed with the thrills and interest of one of the fastest sports in the world and involving a well known sporting arena, has recently come before the New York State Courts.

The owner of Madison Square Garden filed suit against a moving picture producer and distributor, charging unfair competition arising out of a motion picture involving ice hockey In the complaint, the plaintiff pointed out that Madison Square Garden was a sporting arena constructed at great expense, and that it was designed so as to have a large ice hockey arena in which professional and amateur games could be played. The plaintiff also pointed out that he controlled one of the best-known professional hockey teams, the New York Rangers, who were members of the National Hockey League. In order to take moving pictures of hockey games played in the arena it was necessary to obtain plaintiff's permission. The plaintiff then charged that the defendant, knowing these facts, and knowing further that he would have to pay a valuable consideration in order to obtain permission to take moving pictures for use in a feature moving picture play, had produced a moving picture which, while it actually did not have any pictures of games in Madison Square Garden, contained scenes purporting to show professional ice hockey games in New York City, and that many people were misled into believing that they were viewing games being played in Madison Square Garden. In order to encourage this impression on the part of the public it was also charged that the defendant incorporated in the moving picture, photographs taken in a Detroit arena during the Stanley Cup Series of the year 1936-1937, particularly showing plaintiff's team, the New York Rangers.

In its advertising circulars and literature, the defendant repeatedly referred to Madison Square Garden, and it was charged by the plaintiff that when these statements and references were read by the general public they believed that they were viewing professional ice hockey games played in Madison Square Garden.

The defendant made a motion to dismiss the suit on the grounds that the general charges made by the plaintiff in the bill of complaint, as summarized above, did not state a good cause of action. The trial court agreed with the defendant and dismissed the suit. However, on appeal the decision of the trial court was reversed and the appellate court held that the complaint stated a good cause of action. The appellate court pointed out that the plaintiff had built up a substantial good will in the name Madison Square Garden, and that it had also huilt up valu-

able property rights in the granting of licenses to take moving pictures of hockey games in Madison Square Garden.

Referring to defendant's moving picture the appellate court stated:

"The public would suppose, and actually did, that the background of the film was an authentic background presenting scenes of actual games in which the plaintiff's team participated in New York. Defendant's circulars referred to the arena as 'Madison Square Garden. Even in a story that is obviously fiction: far as its plot is concerned, defendants should not be permitted, by the unfair practices alleged, to violate and appropriate to themselves plaintiff's valuable property rights."

BELATED TECHNICALITY

DECHNICAL defenses are looked upon with disfavor by the courts. This is equally as true in suits for patent infringement as in other types of cases. In a recent suit for patent infringement, brought by a German corporation and citizen in the Federal Court in New Jersey, the patent in suit was held to be valid and infringed. The issues had been thoroughly considered both by the trial court and by the Circuit Court of Appeals on an appeal taken from the decision of the trial court. Thereafter the case was referred to a special master to determine the amount of damages and profits. At this stage of the proceedings for the first time the defendant raised the defense that the German corporation and individual had never actually appeared in the case and accordingly had not subjected themselves to the jurisdiction of the court. Plaintiffs had appeared in the case only by counsel.

The Court pointed out that where an attorney appears for a party in a legal proceeding it is presumed that he has authority from the party to so appear. It also pointed out that this is purely a technical defense and that the defendant should have raised it prior to the trial instead of waiting until after the case had been decided by the Trial Court and reviewed on appeal

BABY BATH

Nour complex civilization even babies be come involved in patent litigation.

In a recent case one of the courts upheld the validity of a patent covering a popular type of collapsible infant's bathtub identified by the name "Bathinette." The patented bathtub consisted of a collapsible support, a tub made of flexible material mounted on the support, and a dressing table pivotally connected to the support so that it could fold from a position overlying the tub to a vertical position exposing the tub. The defendant in the suit was originally licensed to manufacture bathtubs under the patent. However, prior to the institution of the suit the defendant had cancelled the license agreement and had continued to manufacture the bathtubs without the patentees' permission. The patentees filed suit for patent infringement and in the decision referred to above the court held that the patent was valid and that the bathtub manufactured by the defendant constituted an infringement.

PHOTO ELECTRIC

RECENT decision of scientific interest, involving the most widely used television system, has been handed down by the Federal Court for the District of Delaware. This decision holds that the well-known television pioneer Vladimir K. Zworykin is the inventor of the system. A-ide from the fact that the court credits Mr. Zworykin with the invention of this system, the decision is of interest to inventors and to industry because it illustrates two important points. The first point is that applications are frequently kept pending in the Patent Office for protracted periods of time without any fault on the part of the inventor or on the part of the Patent Office. Mr. Zworykin's patent application was filed in 1923 and was still pending at the time of the decision due to the fact that it became involved in a series of interferences with the applications of other inventors claiming to have conceived the whole or part of the system described in the application.

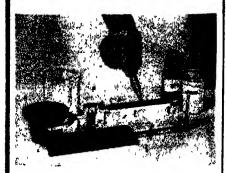
The second point illustrated by the decision is that while no new matter may be added to a patent application after it has been filed the patent application may be amplified so as to include matter which is obviously necessary and well known.

The photo-electric cell employed in the television system involved in the dispute consisted of a layer of aluminum foil, an intermediate layer of an insulator, such as aluminum oxide, and a layer of potassium hydride. In order to make the cell effective for television purposes it is necessary that the layer of potassium be formed of discrete particles electrically separated from each other. As originally filed, the Zworykin application did not specifically state that the layer of potassium was formed of discrete particles. However, it was subsequently amended so as to include a statement of this character. It was contended by Mr. Zworykin's opponent that the amendment constituted the insertion of new matter into the patent application and accordingly was improper. The Patent Office sustained this contention and suit was filed in the Federal Court in behalf of Zworykin. The Federal Court took a different viewpoint from the Patent Office. The Court found that at the time that the Zworykin application was filed the current literature showed that it was well known by those skilled in the art that the layer of potassium had to be formed of discrete particles. The Court also found that the current literature of the time showed that the only way known for making a photoelectric element of this character was by the process of depositing potassium from a vapor and that the potassium when thus deposited could exist only in the form of separate and discrete particles or globules. Under the circumstances it was held that the amendment did not insert any matter in the application but merely amplified it by including a statement of what was obviously necessary and also well known in the art at the time.

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JACOB DESCHIN, Amateur Photography CHURCHILL EISENHART, Department of Mathematics, University of Wisconsin Statistician, Wisconsin Agricultural Station

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NINETY-FIFTH YEAR

ORSON D. MUNN, Editor

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IN digging trenches for pipelines which will transport oil, as described in the article starting on page 212 of this issue, a ditching machine is employed. As our front cover illustration shows, this machine frequently is used on such steep slopes that even the crawler-mounted machines are incapable of negotiating them under their own power. To help them up the slopes a cable is run to a winch mounted on a tractor which is securely anchored to a tree.

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50 Years Ago in . . .

SCIENTOPIC A MOERICAN

(Condensed From Issues of April, 1889)

EMPLOYMENT 'Exequently one sees appalling computations of the vast number of workmen who are constantly thrown out of employment by new mechanical inventions that take the place of human hands. But along with the displacement of hand labor there has gone a replacement, in consequence of the increased production that always follows a cheaper process of manufacture. It must be admitted that though mechanical inventions have put a great many persons out of work, they have also put a great many more persons into work."

UNDERGROUND WIRES—"The work of removing the actual telegraph, telephone, and electric supply lines in this city, with a view



to forcing the electrical supply companies to use the subway system in such streets as contain it, has been vigorously prosecuted during the past week. A very impressive feature of the operations is the comparative darkness to which the city in these parts is relegated at night. The gas lamps are quite unable to supply sufficient light for the people, who have now been accustomed to electric illumination. It is to be hoped that the electric light companies will make every effort to start their lamps anew and give the many centennial visitors a good illustration of subway electric supply and illumination."

BLACK SNOW—"At Airken, Minn, on April 2, at 1.45 o clock, it became so dark that lights were necessary in business houses, and the an was filled with snow that was as black and dirty as though it had been trampled into the earth. Six ounces of snow and one-fourth ounce of dirt and sand were found in the bottom of a dish. The dirt is very fine, something like emery, and contains particles that have a metallic luster. This dirty snow fell to the depth of half an inch. The atmosphere at the time presented a peculiar greenish tinge,"

TRANSATLANTIC—"The new and magnificent ocean steamer City of Paris arrived at this port on the Hith inst, on her first trip, having made the vovage from Queenstown in the remarkably quick time of 7 days, 11 hours, 39 minutes. It is believed her speed will be increased after a few more voyages have been made and her machinery becomes a little worn. As it was, the vessel made 498 miles as her tastest single day's run."

NIAGARA — There have been recently two very heavy falls of rock at Niagara Falls. At first a mass of rock fell from the Horseshoe Falls, and twenty-four hours later another mass was precipitated into the abysis below . . . The result of the displacement is a change in the shape of the fall. Formerly the Canadian portion of the fall could be described as a horseshoe; but the breaking away of rocks in the center some years ago made it V shaped. Now that a further displacement has occurred, the fall has returned to its old condition.

DIAMOND—'The 'Iulius Pam' diamond, which is valued at from 15,000 to 20,000 pounds, has arrived in London from Kimberley It weighs 241½ carats, or fully 90 carats more than that other beauty, the Porter-Rhodes diamond, and was found in the New Jagers-fontein United Mine. — The only larger diamond in existence is the Imperial, but it is said to be inferior in quality to the 'Julius Pam'."

ELECTRICITY—"Professor Elisha Gray remarks that electrical science has made a greater advance in the last twenty years than in all the 6000 historic years preceding. More is discovered in one day now than in a thousand years of the middle ages. We find all soits of work for electricity to do We make it earry our messages, drive our engine, ring our door hell, and scare the burglar, we take it as a medicine, light our gas with it, see by it, hear from it, talk with it, and now we are beginning to teach it to write."

TELEPHONES—"In probably no country in the world has the telephone come into more general use than in Sweden. Not only can Stockholm boast the most perfect telephonic arrangements of any capital, in addition to the largest percentage of telephone subscribers, but the east coast and the west coast will soon be in telephonic communication, a line between Stockholm and Gothenburg being in course of erection."

RECTIFIER—"A device which may be of considerable value is described by M. Neyrencuí in the Journal de Physique as an electric valve, by means of which the current can be sent in one direction, but not in the other. With a voltameter constructed of two aluminum electrodes, dilute acid as electrolyte, and an alternating current, he found that pure hydrogen was evolved at both electrodes, but on making up an arrangement with one electrode of aluminum and one of mercury, the current was found to pass in one direction only."

SWAY-. "The oscillation of high structures in storm winds is a much observed fact, and has probably been the cause of many failures in high chimneys by collapse or permanent set out of plumb by excessive pressure from the rocking motion set up in gales of wind... The Eiffel tower will no doubt be affected to a marked degree by high winds. Although its form of structure is of the least area to the force of the wind, its form and elastic material favor large oscillation in storm winds."

TEAK—"So indestructible by wear or decay is the African teak wood that vessels built of it have lasted fully one hundred years, to be then broken up only on account of their antique mould or defective sailing qualities."

AND NOW FOR THE FUTURE

Chafety factors in an transportation that have been made possible by scientific research.

(Treachetous waters are being battled by engineers bent on saving Niagara Falls, by R. C. Skerrett.

d'Animals, man's henefactors in many ways, can also be carriers of serious diseases, by William Wolf.

(Mechanization of lumbering operations speeds production, by Andrew R. Boone.

CStrange behavior of liquid helium puzzles pure stience research workers, by Prof. Thomas H. Osgood.

Big in Value



...Little in Cost

Few things give you so much convenience, happiness and security—all rolled into one—as your telephone.

Telephone service is not only exceptionally good—it's cheap.

Nowhere in the world do people

get so much service and such good service at such low cost.

Experienced management, trained people and good equipment are three important reasons for this fact.

BELL TELEPHONE SYSTEM



OUR POINT OF VIEW

More Tax Diversion

EACH year the 10 percent excise tax on sporting arms and ammunition, levied under the Pittman-Robertson Act, is supposed to be ear-marked for use by the various states for wildlife restoration. Because it would assist restoration or restocking of game, sportsmen have not looked upon the Act with disfavor

It appears now, however, that somebody in Washington has had a brilliant idea: diversion to other uses of more than two thirds of the revenue obtained under this Act. Reliable estimates of this revenue place the full amount at \$3,250,000. Yet the recommendation for the appropriation to the states, when recently presented to the 76th Congress, was just \$1,000,000. Where is the other two and a quarter million? Going to build a post office for some tank town, or some other political extravagance?

To us, this attempted expropriation of moneys for other than their legal purpose is reprehensible in the extreme, and we therefore repeat here and wish to emphasize statements in the report of the House Committee on Wildlife Restoration:

"The Committee is of the opinion that by proper administration and intelligent co-operation the Pittman-Robertson Act can be made the beginning of a national wildlife program, which if carried out to the fullest extent possible under the law can prove as beneficial to wildlife restoration and management as the Federal Aid Highway Act has been to the State highway systems of this country.

And it is our earnest recommendation to the Congress that the present excise tax on arms and ammunition be continued and that the full amount of the tax so realized be appropriated in the future for use under the provisions of this act " - F D. M.

Who Profits Most?

PIME and time again this page has Time and time again and pointed out the necessity for retaining the profit motive in the patent system of the United States. So have, also, many other authorities on patents and inventions. Yet we have before us the spectacle of a Congressional Committee, supposedly impartially investigating monopolies, indicating by many of its questions to witnesses an attitude prejudicial to the taking of a profit from an invention by the developer. Were this belief in the "guilt" of inventors confined strictly to the Committee, no great harm would be done; but, unfortunately, the members are, ex officio, authorities on this

subject and their words have the force of propaganda to sway the unthinking portion of our citizenry. Already, newspaper reports of their investigations of several industries have aggravated the too general, erroneous feeling that industrial patent holders are not to be trusted

As a recent witness for the 'defense' before this Committee, Dr. Vannevar Bush, president of the Carnegie Institution, was most effective. Taking from his pocket a little strip of metal about an inch and a half long, he explained that one company had spent \$100,000 to develop it. Warmed by the heat of his hand, it performed with a snap, it is a thermostat for use in electric irons and other appliances. At this enormous cost, it goes without saying that no individual or company would have developed it without the assurance that the patent law permitted a profit on its manufacture and sale. It is equally obvious that research of the kind that made it possible would be quickly and entirely abandoned by corporations should the present 17-year patent period be sharply cut or if general licensing of patents were compulsory under the law.

This seemingly simple yet costly development is but one of thousands made every year, also at great cost, in the interest of the public's comfort, convenience, and general well being. It is the people who benefit, even though the developer does make a profit for a few years. It is the people who must understand this fact and, knowing that the greatest profit is thens, take a determined stand against unstudied modifications of the present patent system F D M

Resources

RECENT plea by the Administra A tion for a survey of the natural resources of the nation strikes a responsive chord in the editorial heart of Scientific American. But at the same time it creates a feeling of apprehension that will not down We have always been in sympathy with efforts directed toward conservation of lumber, coal, metals, and so on, we have given active editorial support to further the cause of those striving intelligently to this end. But we have seen the results of all too many governmental surveys--a new bureau set up, millions of dollars spent in field work and for endless reports that might well have been written in the reference room of a public library And then silence.

It is not too naive, we hope, to cling to a straw of optimism and to dare to look forward to the time when a lavishly en-

dowed government bureau will produce a plan that can be handed to the people of the nation to serve as a guide to coordinated conservation. It must be admitted that such a guide, if properly prepared by competent specialists, would be of tremendous value to industry, agriculture, and the public as a whole.

We do feel, however, that the same end can be reached-more economically, more efficiently, and in the same length of time-by those whose best interests will be served in the long run by the application of conservation principles that are well known today. This statement is made in no spirit of laissez-faire, but rather from a knowledge of how indus try in general is meeting and solving its own problems to its own and the public's advantage. Some scandal mongers and mud slingers to the contrary, this nation is no longer ruled by robber barons whose only aim is to despoil for their own benefit, and the devil take the hindmost Modern industrialists realize full well that our natural resources are not unlimited; that they profit most when they apply conservation tactics to the full Modern agriculturists are working along the same lines. The public is on the receiving end and is reaping the benefits And these benefits are accruing with a minimum of drain on the national treasury, a fact that will not be true if the Administration goes too far in its laudable but perhaps misguided efforts to study the whole problem of conservation. The money so spent might better be left in the hands of those who would apply it to practical methods of conservation rather than to the formulation of theories that make fine reading but are lacking in value when put to test.

It may help to clinch our argument if we cite a generalized example of conservation practiced for the much-kicked around profit motive. Years ago far-seeing lumbermen came to realize that stands of timber were not inexhaustible, that they could not ruthlessly cut down trees and leave the countryside a barren waste. They found that indiscriminate logging was not the profitable way and that it would interfere with future gain. So, just as any sensible business man would do for his own protection, they began to plan their operations on a conservative basis. Selective logging and tree-planting programs were inaugurated and, as these practices are applied more and more, we have little to fear for the future of this important industry that is tapping but at the same time replacing one of our important natural resources.

-A. P. P.

Personalities in Science

TO Dr. Edwin Hubble, of the Mount Wilson Observatory, in California, recently was awarded the Bruce Gold Medal of the Astronomical Society of the Pacific, 'for distinguished services to astronomy." Within the past decade Di Hubble has become an astronomer of outstanding world recognition.

On the occasion of the presentation of the medal Dr. Harold D Babcock, president of the Society, gave an account of his career and accomplishments, a part of which is quoted from the Society's Publications

'Dr Hubble was born at Marshfield, Missouri, November 20, 1889. His undergraduate studies, emphasizing mathematics and astronomy, were completed in 1910 at the University of Chicago, where, against spirited competition, he won a Rhodes Scholarship, a recognition of his promise for the future. The ensuing three years of study at Oxford, centered in the field of law, were followed by the degree of Master of Arts in 1913. On his return to the United States he was admitted to the Bar, but he soon found that his strongest interests remained in science. He resumed the study of astronomy at Chicago, became, in 1914, an Assistant at the Yerkes Observatory and a pupil of Professor Frost, and in 1917 received the degree of Ph D

Enlisting in the infantry that same fateful year, he served until 1919 in france, was mustered out with the rank of major, and immediately joined the staff of the Mount Wilson Observatory Here he rapidly made a place for himself in his chosen field, as testified by his receiving the \$1000 prize of the American Association for the Advance ment of Science in 1925, his election to membership in the National Academy of Sciences in 1927, his selection as Halley Lecturer at Oxford University in 1934—a rare distinction for any non-British astronomer—and the award to him of the Barnard Medal in 1935.

"Even before he received his degree, llubble showed evidence of his skill as an observer. On taking up his researches at Mount Wilson, he boldly attacked the vast problem of determining the scale on which is constructed that part of creation within the range of observation.



EDWIN POWELL HUBBLE

Aided by the best equipment thus far available for the purpose, he has been able to establish new outposts of knowledge through the application of accepted methods and of new developments in technique

Dr. Hubble was the first to establish a reliable scale of distances for objects observable with the 100-inch reflector and farther away than the Magellanic Clouds. He has brought within the domain of the measurable a sphere of radius 500 million light-years. The volume of space now subject to exploration is a thousand million times as great as that amenable to quantitative discussion only 20 years ago"

After describing Dr. Hubble's researches on the Andromeda Nebula, made prior to 1929, which provided "almost conclusive evidence in support of the island universe hypothesis"—observations which "alone would attract the interest and respect of all astronomers"-Dr. Babcock refers in summary to the cosmological significance of his observations in general. "They certainly have reacted strongly upon the thinking of the greatest theoretical physicists and astronomers, have stirred the depths of philosophical speculation, and, perhaps more important than anything else, have clearly shown the need for still greater instrumental power. It is not an overstatement to say that the convincing data assembled by him with the 100-inch telescope have been a powerful argument for the construction of the 200inch reflector "

Dr. Hubble is the author of a recent book, "The Realm of the Nebulae," embodying in semi-popular form the results of his researches in the subject of his specialty.

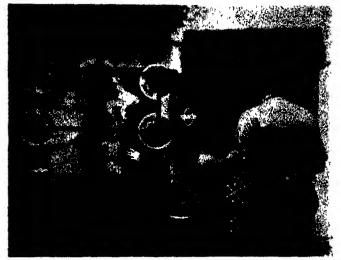


A MAGNIFICENT TIDAL FRONT IN A CHINESE RIVER

BY rising more rapidly in the seas than they can flow into adjacent land channels without producing an uncommonly steep front, the tides in a few suitably situated places on the earth produce bores, especially when sun and moon conspire to produce maximum rises A bore (old Scandinavian word meaning "wave") occurs in the narrowing Bay of Fundy, also in several English rivers. The bore shown

above is a heavy one which occurs at flood tide in extreme eastern. China, near Hangchow, on the Tsientang. The bore rushes up the river at quite considerable speed, raising the water level many feet, mainly at the steeply shoping face. The standing figures on the distant bank give the scale. The fury of this thundering "wall" of swift, turbulent water is awe inspiring and the natives never tire of witnessing it.





In a television studio. Left. Directing a scene on a "live" stage. Two cameras are used to introduce variety in the angles of view. Right. Another stage setting showing, in the foreground, the latest type of lighting equipment used in television studio work

HERE COMES TELEVISION!

Will Serve Entertainment Needs . . . Technical Equipment Has Limitations . . . Standards Laid Down to Prevent Obsolescence of Receivers

By O. B. HANSON
Vice President and Chief Engineer
National Broadcasting Company

NOR years people who knew of my connection with television have been asking: "When do we get it?" Whenever the temptation to predict grew strong within me, I would mentally turn the pages of old magazines—"Television Comes to the Home" (1928), "Television Gets Ready for Business" (1930), and so on—then mutter a few incomprehensible phrases and let it go at that. Now I am in happier circumstances. Broadcasting of regular television programs to the metropolitan area of New York will start in April. The same time has been chosen for marketing the first commercial receivers. Together, the two events mark the real beginning of American television.

It is probable that the average intelligent reader, having scanned a few magazine articles and news stories about television, has arrived only at the point of confusion. Perplexing questions popinto existence, speculation arises, and nobody seems very certain of anything about television. Television is bound to have profound effects on our social order. It will affect existing industries, create at least one new one. Some day it may encroach on other entertainment and educational media. Perhaps it will cause a change in the styles of presen-

JUST prior to the arrival of scheduled television programs on the American scene, we present the accompanying article to give a comprehensive view of the situation as it stands today. Written by Mi. Hanson at our request, it clears up many misconceptions about the subject—The Editor.

tation that will be used in other media.

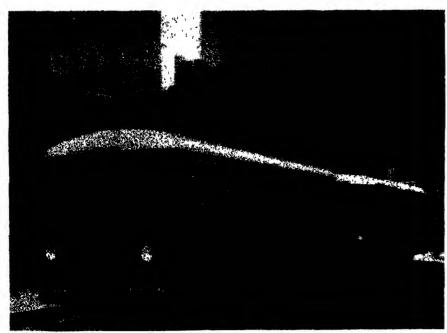
Will there be national television networks? What about the movies and television? Who will appear on the television screen and what will the programs be like? And what is television and how does it work?

Let me begin with the last question. A convenient definition of television is "the transmission of scenes or images in motion, by electrical communication methods." Broadly, it is a radio medium designed for the entertainment and education of the home audience. The television system which has gained widest acceptance is entirely electronic, without a single moving mechanical part. Its bright, moving images are in black and white, filled with interesting detail

and without a trace of flicker. The transmission apparatus, although almost infinitely complex in design, is entirely reliable. In a recent demonstration at Washington, D. C., in which the NBC mobile television units were the transmitting station, not one minute was lost in more than 30 hours on the air through equipment failure. I assume that the commercial receivers soon to be marketed will also be reliable and simple in operation

MY description of television's appa-ratus will naturally veer toward the technical And since I am most familiai with the NBC equipment, I shall use it as an example. Our apparatus embodies the RCA all-electronic system of television. In the camera, fitted with a photographic lens system, the light image is focused on a photo-sensitive mosaic inside the Iconoscope, a highly evacuated tube shaped somewhat like a dipper. The photo image is here registered and its light values converted to electrical potentials. We have here a "picture in volt ages," which, to be useful, must be analyzed, taken off the mosaic, amplified, and broadcast

The analysis, or "scanning," is accomplished by a beam of electrons originating in the neck of the Iconoscope and focused on the mosaic to the fineness of a pin point by an electrostatic lens. The beam is drawn across the mosaic, by horizontal and vertical deflection coils, in a predetermined pattern of 441 lines at the rate of 30 frames a second. Actually the rate of scanning is 60 half-frames, or "fields," per second. Interlacing—scanning of the odd lines dur-



Mobile television unit consisting of two trucks that carry all equipment necessary for relaying television programs from remote points to the main transmitter located some miles away

ing the first field, followed by the evennumbered lines in the second—completely eliminates flicker

In so scanning the mosaic, the electron beam neutralizes the charge that has accumulated on each element of the mosaic. In so doing, the beam sets a current flowing in the circuit; in aggregate, these impulses constitute the vision ("video") signal. They are amplified many times and sent to the transmitter either by radio relay or coaxial cable, where they modulate the station's ultra high frequency carrier before being broadcast over a specially designed wideband-pass antenna system

At the receiver, after again being amplified, the video signal modulates the electron beam in the neck of a large funnel-shaped vacuum tube called the Kinescope. The modulated beam is drawn over a fluorescent screen of zinc sulfide at the large, or screen, end of the tube in the predetermined pattern of 441 lines, 30 times a second. And since the light values created in the fluorescent screen vary directly with the intensity of the electron beam, a replica of the original image is produced. Viewing is either direct from the end of the tube or by reflection in a mirror.

This is the system we shall use in inaugurating our television program service in the New York area. We are confident that with the inevitable technical improvements that will develop once a television service gets well under way, the system will serve the needs of the American people.

Our technical facilities at W2XBS include studios for both live talent and



Mr. Hanson, author of the accompanying article, with one of Iconoscope tubes used in transmission

film programs, and a mobile television station for outside pick-ups. This latter should be of great assistance to us in presenting programs from athletic stadia, parades, and sidewalk interviews, and all types of outdoor news events, in addition to floor shows from popular night clubs and hotel grill rooms. We shall use either our present mobile station, or one similar to it, in televising the next Presidential Inauguration in Washington, D. C.

Our studio for live talent programs is fitted with three Iconoscope camerachains for multiple camera pick-up of performances. This assures the variety of shots necessary in the pictorial art. Switching from one camera to another is done in the studio control room by means of push-buttons. Several projec-

tors and cameras are located in the film

All technical equipment has its limitations. Television apparatus offers no exception. Our camera's depth of focus still leaves something to be desired, although improvements are constantly being made in this respect. Likewise, the spectral response of the Iconoscope is not equivalent to that of the human eye, though its range is considerably greater, since it extends into the infra-red frequencies.

In a more practical sense, television service at present is limited to a few transmitting stations. NBC has been broadcasting intermittently with the RCA all-electronic system of television since June, 1936. Several other stations employing the electronic system, how ever, will soon be broadcasting. One other station is licensed in New York City, another in nearby New Jersey and two others upstate. Bridgeport, Connecti cut, will be the location of a sixth eastern station. Most of these will be isolated stations, although I believe the two in upstate New York will be interconnected by radio relay

THIS brings us squarely against the problem of television networks. If television is to fulfill even a small part of its promise it must create networks Spontaneity will be the life blood of tele vision, and it cannot deliver news events to viewers in many cities, while they are still happening, without building net works. Eventually, I am sure, the country will be covered with such networks in much the same manner as radio net works reach into all parts of the United States today. Economic considerations also make the creation of such networks imperative, but technical and cost problems still limit our progress in this direction Most circuits comprising our national sound radio networks cannot transmit sound frequencies beyond 5000 cycles. Good television demands circuits capable of transmitting a band of frequencies from 30 to 4,000,000 cycles per second for the video signal alone.

Two methods are available. The coaxial cable, a concentric conductor capable of passing the wide band of frequencies used in television, is apparently the new art's equivalent of the wire circuit used to interconnect sound broadcasting transmitters. One such experimental circuit, connecting New York and Philadelphia, is already in existence, although some modification of it would he necessary if we were to transmit 441line images over it. Its cost, I understand. was about \$5000 a mile. The other possibility for networking is the use of automatic beamed micro-wave radio relays which, in tests, have given us reason to suppose that they will be at least an important element in the final answer to television networking questions. Neither of these is in existence in any practical sense, nor is either likely to be available for any national network for some years to come. However, the availability of a limited micro-wave network along the castern seaboard is a distinct possibility before the Presidential Inauguration of 1941. The probabilities are that, for at least a decade, television will be confined to more or less isolated stations located in the larger centers of population, and serving perhaps a little more than 50 percent of our population.

Another very practical limitation is tound in the frequencies used in television. Because of the necessity of transmitting a vast amount of information within an exceedingly short time, the developers of television had to turn to the ultra-high frequencies-waves between ten meters and one meter in length. This brought some decided advantages, it also brought some disadvantages, the chief of which is the fact that the range of high-quality reception is practically limited by the visual horizon as seen from the transmitting antenna. The NBC transmitter, with its antenna on the very top of the Empire State Building, highest building in the world, reaches out about 55 miles, although pictures have been received up to a distance of 100 miles. Perhaps when we have learned more about tube design and can obtain greater power output than the present 30,000 watts peak we shall extend our service range. That is a matter for the future to decide

ON the other hand, within the service range an excellent signal is laid down. Ordinary static is not present on these frequencies but man made static, such as is created by diathermy apparatus, electric razors, and faulty automobile ignition systems produce interference that is detrimental to television reception. Future laws may require the installation of suppressors on all electrical equipment radiating energy that interferes with television and all other communications service on the ultra-high frequency bands.

I have emphasized some of the problems of ultra-high frequency transmission. I hope that I have not given the impression that they are of such gravity as to ruin television's chances of success. In my own home, about 46 miles from the Empire State tower transmitter, I enjoy the reception of excellent images. I am quite sure that everyone within the metropolitan area of New York who invests in a receiver and has it properly installed will also enjoy a unique type of entertainment.

This brings up the question of the type of entertainment television will probably offer in the near future. Today's television, as I have indicated, is capable of broadcasting studio productions by live

Title of the first on the growth and the best that he call

Right: A television receiver of the type that will be available for home reception of sight and sound by radio. The image is viewed in a slanting mirror in the hid of the receiver, showing the funnel shaped shield of the cathoderay tube (Kinescope) that makes images visible





talent, motion picture film, and outdoor programs relayed by a mobile television station. A single production, in fact, might embrace all three types. In the past we have successfully combined action in our live talent studio at Radio City, films of outdoor scenes and still pictures from a projection room, and special effects from yet a third studio into one production.

The NBC television program staff, under the direction of Thomas H. Hutchinson, has been experimenting for two years and more with numerous types of material. Some, conspicuously successful in other media, have been found to he dismal failures in television. Others were found to have television qualities; all needed adaptation. What is required is a rather fast pace, an ease of performance, and a certain spontaneity that registers well in television. Up to the present we have found no accurate yardstick that will measure in advance the success of any given act or performer on television.

During the experimental period, Hutchinson's staff has put on a variety of plays, motion pictures of all types, educational material, vaudeville and nightclub entertainment, orchestras, and what not, Magicians, jugglers, trained dogs, a scientist showing the microscopic life in a drop of water, a book reviewer, legitimate actors and educators have tried their talents on the new art. The individual items have run all the way from an individual turn of ten minutes or so to dramas and fashion shows of 35 minutes or more. We have put on sidewalk interviews, both day and night, picked up a floor show in a nearby cafe, and televised the graceful gyrations of skaters on an outdoor rink. We have covered a spectacular fire.

These are beginnings only, but I believe they offer promise that television programming will develop into something both highly interesting and informative. Certainly no other medium will be able to compete with television in furnishing programs of news events. Television will be on the spot and will flash the scene into the home while it is still happening; when the program begins neither the engineer behind the camera nor the viewer at his receiver will know what the outcome will be.

But what about television's effect on the motion-picture industry? The motion picture, like all theatrical entertainment, is of mass appeal; an audience must be present in large numbers to get fullest enjoyment from one of the theater's spectacles. Much of the appeal, therefore, is social; going to the theater or the motion-picture house is a social event. The wife wishes to dress and get away from the home scene for a few hours, to mingle with hundreds of others motivated by the same impulse, It is not likely that television, or any other medium that enters the home will ever (Please turn to page 251)

QUICKER THAN THE EYE

THE human eye is a pretty good pyrometer. In estimating temperatures that are high enough to bring about the emission of light, the eye has served the steelmaker effectively for at least 3000 years. Only within the past decade or two has it really begun to be taxed beyond its capacity as an aid in steelmaking

Considered as a pyrometer, or as a camera, or merely as a means of getting about in the world, the human eye has two serious weaknesses: it is slow, and it is easily fatigued.

Everyone who has dabbled in amateur magic and sleight-of hand knowshow easy it is to make quick movements that the eye cannot follow. Many steel-making operations are now so fast that it is impossible to follow them visually, at any rate to the extent that one could say afterwards that this or that part of the steel was too hot or too cold.

As for fatigue, look at a bright light of toward a window, and note how the outline persists after the eyes are closed. Or start at an intermittent colored sign and note the complementary color that appears momentarily as the lights go

out. These effects are but momentary, but they can be cumulative, who has not felt the depressing effect of overex posure to bright sunlight or to the flickering movie screen? Modern steelmaking processes, at least those that are operating continuously, can no longer be controlled by casual and occasional inspection. They have to be watched, persistently, and the human eye just can't take it.

At this point the photo electric cell steps into the breach and provides an eye that is in some respects as sensitive and also as discriminating as our own but at the same time is much quicker and much less subject to fatigue

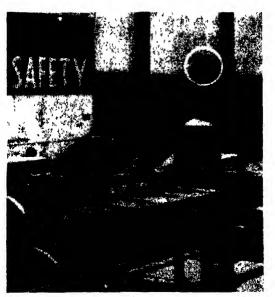
Two types of photo-electric cell have found use in pyrometry. One of these is the cesium vacuum cell, requiring an applied voltage, familiar to all amateur and professional experimenters with electron tubes. The other is the type used in large numbers by camera enthusiasts in their exposure meters. This is the Photronic or barrier layer cell, a self-generative type of photo-electric cell which requires no applied voltage.

Demand for Better Steel Has Made Necessary More Careful Control of Processes . . . Photo-Electric Cell Measures Temperatures Accurately

By ROBERT B. SOSMAN, Ph.D., Sc.D.

Research Laboratory, United States Steel Corporation

In the cesium cell the external voltage is supplied by a storage battery or rectifier, when light falls on the cell the variations of current in the circuit can be used to indicate and record the temperature of the hot surface from which the light came. In the self-generative type of cell. a metallic plate is coated with a mixture of seienium and other substances. This layer in turn is coated with a layer of vaporized metal so thin that it is transparent. One electrical connection is made to this layer and the other to the metal plate. If a meter is placed in the circuit and the light from a hot object is allowed to fall on the cell, the current m the circuit will be in proportion to the light intensity and again we have a means for indicating and recording the temper



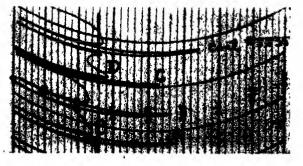
Above, in circle: Photronic photo cell mounted above a roll table in the strip mill at Fairfield Works of the Tennessee Coal, Iron, and Railroad Company. Right: A sample of slab-temperature record made by a Photronic pyrometer on a strip mill

ature of the surface from which the light came

An application of the cesium photoelectric cell to the steel mill is in the so-called "Optimatic" pyrometer, mount ed to read the temperature of the fast traveling strip of metal in a modern hot strip mill. This mill takes a hot slabof steel and converts it at steadily in creasing speed into a ribbon hundreds of feet long and several feet wide, which is later cut into sheets for tin cans, automobile fenders, and innumerable other uses. So much depends upon proper temperature in the strip, as well as proper speed, roll pressure, and tension, that the estimation of temperature by the unaided eye is no longer dependable

The Optimatic pyrometer has a matched pair of cells, but does not use the pair in quite the same way as we use our own pair of eyes. It looks down on the hot surface of the strip with just one eye, while it cocks the other eye toward an incandescent lamp. Through the operation of a set of electron tubes the current in the lamp is caused to change until the lamp matches in brightness the hot surface, and the lamp curient thus serves as a measure of the temperature. All this takes place much quicker than I can tell about it, and the record of temperature is made within a fraction of a second after the pyrometer sees the steel.

IN the Research Laboratory of the United States Steel Corporation we have preferred to depend upon the Photronic type of cell, and in this way climinate some of the troubles incident



but to the state of the

to the use of a rectifier such as is necessary for the cesium cell. In one application, a Photronic eye, carefully water-jacketed to protect it from damage by heat, looks down upon the roll table along which the hot slabs for the strip mill begin their journey. When it is first seen by the pyrometer, the slab has already been given a squeezing and cleansing that gets rid of the coating of scale formed upon it in the heating-furnace. The slab is thus left with a clean, glowing surface whose temperature is instantly recorded by the electric eye.

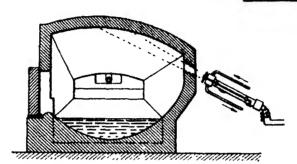
One of the illustrations shows a portion of the automatic record made by the pyrometer on a moving strip of paper. At the point A, the slab has just passed under the eye or receiver and has flashed its temperature, but was in sight for such a short time that it made only this single record of temperature. After several passes back and forth through the first set of rolls, however, it had lengthened out so much that it reached clear back again under the pyrometer and made a second record, B. This time the greater part of it passed back under the pyrometer as the strip emerged from the rolls, then went forward again through the last pass, thus doubling its appearance on the record, If its temperature had been uniform and had not changed during this brief interval, it would have drawn a vertical straight line, but the surface is, of course, cool ing all the time and if uniform from end to end should make an inclined straight line. If hotter at the rear end, on the other hand, it should make a "V". This was actually the case with the second tollowing slab, registered at C, when it came back to make its longer record, at D. These variations are nearly or quite invisible to the human eye but they tell men in charge of the heating and rolling a good deal more than they would tell you or me,

ANOTHER application of the photo-electric pyrometer, this time one in which absence of fatigue rather than quickness is its most valuable characteristic, is found in the so-called pyrometric roof control in the open-hearth furnace. This is a furnace into which cold scrap steel is loaded through wide front doors, to be melted down by a flame of gas, oil, or tar. After the steel is melted, liquid cast iron from the blast furnace is poured in, and the mixture 18 then held for several hours while refining takes place. In the refining action, the impurities are hurned out of the material and absorbed by the slag on top of the metal, leaving only pure iron behind.

The limiting factor in the speed of such a furnace is the melting temperature of the roof and walls. These are usually built of silica brick made from

sandstone or quartzite, the white rock that forms the high ridges of central Pennsylvania. These silica brick melt sharply at 3142 degrees, Fahrenheit, just as sharply as a piece of ice melts at 32 degrees. Fahrenheit.

In the presence of the vapor of iron and iron oxide that is present in the openhearth furnace, silica brick melts at a temperature lower than this, in fact, very close to 3000 degrees, Fahrenheit. The furnaceman dare not let his roof pass this temperature else it begins dripping into the molten steel below, forming "icicles" like those seen along a roof gutter during a thaw It is important that he get the furnace as hot as possible to gain speed in the process, yet he cannot stand in front of the fur-



Above: A roof-control photoelectric pyrometer mounted in the back wall of an open-hearth furnace. Left: Diagrammatic cross-section of one of these furnaces, showing how the pytometer is placed. A constant flow of water, indicated by the arrows. cools the pyrometer

nace peering through the wicket of the furnace door, for not only has he other duties to perform but his eves would soon be so fatigued by the brilliance, even though protected by his colored glasses, that he would be unable to judge accurately the temperature of the roof His usual former practice, therefore, has always been to play safe and stay well below the melting temperature of his roof, even though he lost time thereby, because melting a roof is a very expensive accident.

With the electric eye always on the job, however, he can attend to his other duties and no longer be concerned about getting dangerously near the melting temperature. The pyrometer can be connected to an automatic controller which will shut off a part of the fuel the moment the roof temperature reaches the limit which has previously been set on the controller. Then, about one half minute later, when the temperature has dropped back through the prescribed lange of action of the controller, the fuel will again be automatically turned on.

In the open-hearth furnace, the pyrometer is arranged to sight through an opening in the back wall of the furnace upon the middle point of the inside surface of the roof. A record made by one of the automatic controllers shows that the temperature had repeatedly gone just above 3000 degrees but had been instantly pulled back by cutting off fuel, only to come up again a short time later. This really effective service, independent of human judgment, makes work possible at the highest temperature

without danger of destroying the furnace,

The pyrometer, mounted in the rear of the furnace, is protected by a steel jacket through which water constantly enculates, for it is uncomfortably hot in the vicinity and the electric eye is almost as sensitive as the human body to temperatures above 100 degrees. Constant circulation of cold water, however, keeps it in prime working condition for weeks or months at a time.

It need hardly be said that these devices have their little idiosynciasies which have to be learned by experience. For example, if you stood in front of an opening in the furnace wall as long as the pyrometer is expected to stand there, you would probably be stung now and then by a flying particle of molten steel or slag. These particles are projected up by the vigorous boiling that occurs in the steel bath, and occasionally one will fly on such a trajectory that it comes straight out through the opening. It will not do to try to protect the pyrometer by a shutter or screen, as that would cut off the necessary light from reaching the automatic eye. A piece of glass would stop the particle but the particle would stay where it stopped and the accumulation would gradually cut off the view. We want a screen which is transparent and always on the job to catch the particles, but one which will throw them away as soon as they are caught. A jet of althis the ideal screen for this job. It stops none at the light but it deflects the flying particle and renders it harmless.



ern oil tanker, the S. S. J. W., J. an. Dyke, at night, Note I-protected passageway down the center of the deck

IL is found in widely scattered areas, with the richest deposits often hundreds and even thousands of miles from the great consuming centers. From the days of the earliest oil wells, therefore, the development of efficient and economical transportation from the wells to the consumer has been one of the major problems of the industry. The fact that the American motorist pays close to the world's lowest price for gasoline is to a considerable degree due to the success of the oil industry in adapting the various forms of land and sea carriers to the transportation of its products.

During the earliest days of the industry, the output of the well- was barreled and carried by wagons to the small local refineries and from there to the nearest railread siding. Except for some slight competition from canal and river car riers, the teamsters and the railroads enjoyed a monopoly on the haulage of petroleum, Today, the teamsters have disappeared. The railroads, on the other hand, continue to be an important factor, deriving a revenue of \$250,000,000 annually from the crude and refined products shipped by the petroleum industry. Their days of preeminence, however, are past. By far the greater part of the output of the wells is now transported by pipe lines, oil tankers, and motor tank-trucks.

Within the continental borders of the United States there are approximately 345,000 active oil wells, located in 22 states. Fifty-five thousand miles of pipe line gather the day's supply from the wells and carry it to the gathering sta-

THE MOTORIST

tions on the trunk pipelines. From the gathering stations, the oil flows through 60,000 miles of trunk line to 437 operating refineries in 28 states and to marine terminals at coastal points.

From the marine terminals, the crude oil is shipped by tankers to refineries in the United States which are not linked by pipe line to the oil fields, and to ports throughout the world From the refineries, the refined products are shipped by tankers overseas, and to distribution terminals in the United States by inland wa-

terways, rail, and more than 5000 miles of pipe line Forty thousand motor tank trucks carry the refined products from the distribution terminals to the nation's 200,000 filling stations.

TODAY, approximately 75 percent of all the oil produced in the United States is moved by water carriers at some stage of its passage from the well to the consumer. Practically all shipments to points along the Atlantic and Pacific coasts are made entirely by water From these receiving points on the two coasts, oil barges and river tankships carry petroleum products through 30 000 to 45,000 miles of waterways to inland destinations. During a single month, tankers have unloaded as much as 45,000,000 barrels of crude oil, gasoline, and other petroleum products at United States ports

The United States leads all nations in its contribution to the world's total of 1655 oil tankers of 1000 gross tons of over As of June 30, 1938, there were 418 tankers aggregating 2,759,642 gross tons under American registry, not including the oil barges and other craft of less than 1000 gross tons which constitute a big majority of the oil carriers that ply our inland waterways. Tankers constitute about one third of American merchant marine tonnage Petroleum and its products provide nearly one third of all water-borne tonnage in American world trade.

Ocean transportation of petroleum has progressed a long way since the first ship to carry a cargo of oil on the high seas sailed for England from Philadel-

phra in 1861. The vessel was the 224 ton brig, the Elizabeth Watts, and she carried her cargo in barrels. It was not until 1869 that the first oil ship fitted with iron tanks appeared. The name of this pioneer tanker was the Charles, a sailing vessel of 774 tons with 59 tanks Prior to this, the oil had been shipped in barrels, or entire holds of the vessels in the trade had been used as single tanks. The first steam tanker appeared in 1878, and by 1885 more than 1000 ships with a capacity of from 2500 to 14,000 barrels of oil were transporting American petroleum products to United States and foreign ports

Fver since the first tank-fitted ships appeared, the trend has been towards larger, faster, more efficient vessels. It is this search for speed and economy in tanker operation that is directly responsible for the introduction of welding in the construction of the larger vessels during recent years. Welding makes it possible, without sacrificing strength, to reduce materially the hull weight which must be moved by the ship's propelling machinery, while the smooth, welded hull offers less opportunity for surfactoriosion.

One of the first all electrically welded, self-propelled vessels to be built / the United States was the White Flash, a tanker 201 feet 2 inches over-all, with a capacity of 7500 barrels of oil The White Flash was delivered in 1931, but it was not until 1936 that the same construction method was applied to the larger type of ocean oil-carrier. In 1936 The Atlantic Refining Company placed with the Sun Shipbuilding and Dry Dock Company an order for a tanker of 18,500 tons dead weight, in which the entire tank space extending from the engine room bulkhead to the forward end of the tank space was to be of welded construction The vessel was commissioned in February, 1938, and is now on the Philadelphia-Texas Gulf Coast run A sister ship, built for the same company in the same shippard, was completed and placed in service on the same run in August, 1938.

The two new tankers—the J. W. Van Dyke and the Robert H Colley—are the world's largest welded ships and illustrate in graphic fashion the remarkable development that has taken place in the constituction of oil-carrying vessels since the first tank ships appeared nearly 70 years ago. The new tankers have an

Gets His Oil

Oil, Gasoline Distribution Relies On Science For Aid . . . Problem Has Inspired Unique Developments . . . Pipe Lines, Huge Tank Ships, Trucks

over-all length of 541 feet 5 inches. The capacity of each is 156,000 barrels, or 6,552,000 gallons - enough gasoline to supply the average requirements of 10,000 motorists for a full year.

Turbo-electric engines developing 5000 horsepower give the ships a speed of 13 25 knots, enabling them to make the trip between Philadelphia and Texas Gulf ports in six days. Three 300-horsepower discharge pumps, driven by 2300-volt explosion-proof motors, give each of the vessels a rated maximum discharge capacity of 630,000 gallons an hour. With adequate shore pumping equipment, each can be loaded in approximately eight hours.

At some loading points, particularly on the Pacific Coast, where shallow wa ter or lack of harbor facilities make it impossible for tankers to tie up to the docks, oil carriers take on their cargoes through submarine pipe and hose lines that may run a full mile out into the ocean. The vessel is brought into position, anchored, and made fast to buoys anchored to the occan bed. The submarine hose is hauled aboard and attached to one of the tanker's intake pipes. Orders are given by submarine telephone when it is time to begin pump ing in the oil When the loading is completed the hose is cast off, made fast to a buoy to mark its location, and the tanker sets out to sea.

Radio telephone communication between refineries located at tide-water and their tugs operating in the harbor is a recent development that speeds the handling of tanker cargoes. The tug-to-shore radio 'phone communication often saves many hours when a tug that has left the docks is needed in a hurry at some point in the harbor, and it is frequently possible to keep the tugs operating efficiently in thick weather that would otherwise slow them down or put a stop to their activities.

Just as the modern oil tanker is a skilful adaptation of the cargo ship to the transportation of a particular type of cargo, so the oil pipe-line is an equally skilful and efficient adaptation of a medium used for centuries for the transportation of water. For practically all liquids available in large volume, pipe lines provide the most economical form of land transportation that has ever been devised. The cost of transporting petroleum products by pipe line is approximately half the cost of rail transportation.

Since the construction, in 1875, of a pipe line from Oil City, Pennsylvania, to Pittsburgh to transport crude oil, the pipe-line system has spread out over most of the United States, but so unobtrusive and unspectacular has the growth of the system been that few are aware of the enormous, complex transportation network that lies beneath the surface of the country. Thousands pass over the lines every day without a thought for the millions of gallons of oil flowing beneath them.

THERE is not one of the 315,000 active oil wells in the United States that does not have an outlet for its production through a pipe line. When new oil fields have been opened up, pipe lines have always been prompt in providing the new areas with facilities for volume shipment, even in the most remote places. Soon after the discovery of

the East Texas field, the greatest source of oil yet uncovered, 17 trunk lines, capable of moving 1,000,000 barrels a day, were built to serve the new field. During the past year more than 1.215,000.000 barrels of crude oil, and 75.000.000 barrels of gasoline were moved in interstate transportation by the nation's pipe line system. So enormous is the system that it is estimated that more than 5,000,000 barrels of crude oil and gasoline could be moved in 24 hours.

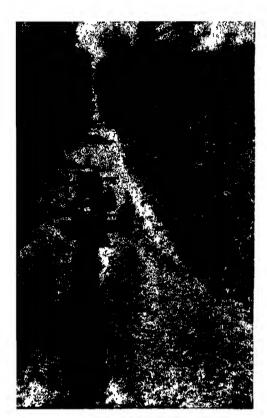
In planning the construction of a pipe line the first problem that must be solved is to find the route between the points to be connected that will permit the speediest and least expensive construction, and the most efficient operation after the pipe has been laid. Conditions of topography, drainage, and rights of way are all factors that must be considered, but the route must follow a comparatively straight line, for a route laid out to avoid all the difficulties of the terrain would probably be so circuitous as to make the cost prohibitive

Actual photographic surveying is a comparatively recent development that is proving an invaluable and to the location engineer. The aerial photographic maps show the engineer all of the surface details in the horizontal plane, and with stereoscopic devices, similar in principle to the old-fashioned stereoscope that used to be standard home equipment, he can obtain a three-dimensional effect that shows all the details of elevation changes.

Such aerial surveys enable the engineer to plot a route across average country in his own office, with the assurance that few, if any, changes will be ne-

Pipe lines to carry oil and gasoline—many thousands of miles of them—spread like sp webs radiating out from the various oil fields to all parts of country. Here, one is being insta





ing machine anchored to a tractor and cuta trench for an oil pipe line on a steep slope

cessary when the route is staked out on the ground. In extremely rough country alternate routes can be plotted on the photographic map, with selection subject to a one-party ground check, whereas without the photographic map it would be necessary to put half a dozen surveying parties in the field to cover the possibilities of as many different routes.

In spite of all the study devoted to the selection of the best available route, nature frequently presents obstacles that test the skill and ingenuity of the construction engineers. A recently completed 225-mile line from Williamsport, Pennsylvania, to Rochester and Buffalo, New York, had to cross three riversthe Chemung, the Genesce, and the Susquelianna-and frequent swamp areas Precipitous, rocky hills and deep valleys, often heavily timbered, not only made difficult the transportation of pipe and other supplies, but placed tremendous strams on trucks, tractors, ditchets, and other machines

Even after trees had been felled, the stumps blasted out of the ground, and a roadway cleared by a machine known as a bull dozer, trucks were frequently unable to negotiate the steep slopes and the pipe had to be backstrung from the nearest accessible spot. The procedure was to weld the pipe into one continuous section and push it down the incline to the next relatively level spot where it could be welded to the section beginning at that point.

Many of the precipitous slopes even defeated the crawler-mounted machines capable of pulling 15 tons or more of deadweight up surprisingly steep grades. To help them up the slopes it was necessary to haul them with a wire cable from

a winch-equipped tractor anchored to a tree some distance up the hill. A machine used to back fill the ditches after the laying of the pipe, and admiringly referred to by the workers as "Popeye," somersaulted 15 feet through the air on one of the slopes, but was quickly repaired and returned to duty

Each of the river crossings presented its own problems. In the case of the Cheming crossing, which was not very wide or deep, a machine known as a trench hoe was mounted on two large timber runners and pulled across the river bottom by two winch-equipped tractors anchored on the far bank, digging a five-foot trench as it went. A barge fitted with an inclined runway was used to lay the pipe across the 1000 foot Susquehanna crossing. The lengths of pipe were welded together on the runway and allowed to settle into the river bot tom ditch as the barge was winched across.

ALTHOUGH virtually every technique in the pipe line builder's manual had to be employed at one time or another to overcome the obstacles set up by nature, the crews employed on the job established some remarkable records for speed. On some of the less difficult stretches, as much as 25,000 feet of line was laid in a single day. The whole 225-mile line was completed in four months from the start of construction

In many respects, the operation of a pipe line is similar to the operation of a railroad, with its feeder or gathering lines, main trunk lines, terminals, storage yards, switch systems, stations, dispatchers, telephone, and teletype systems. Unlike the freight train, however, the pipe line does not have to move itself as well as its load. The fluid is kept moving through the pipes by pumping stations, usually located about 40 miles apart, although in hilly country, or for heavy and viscous oil, they may be placed at more frequent intervals along the route

Each station is equipped with pumps powerful enough to send the stream on to the next station, and is provided with storage tanks having a capacity ranging from 10,000 to 50,000 barrels Frequently three or four different "slugs" or batches, each consisting of from 25, 000 to 250,000 barrels, and each consigned to a different destination, will move in succession through the same pipe line Each "slug" may consist of a different grade of gasoline or other petroleum product. The inter communicating telephone or teletype system en ables the dispatchers to keep the station operators informed of the time when each batch will reach them, and to give the necessary instructions for shunting off the different consignments to the connecting lines that will carry them to their different destinations

No pick and shovel work is necessary after an oil pipe line is laid, a powerful bull-dozer tractor fills the pipe trench and cleans up the job in short order



VITAMINS FROM OUR OWN FISH

TODAY, because a young Minnesota pharmacist found experimenting with burbot an interesting diversion, Lake of the Woods fishermen are selling the once-despised fish for the valuable cargo of vitamins A and D they carry in their unusually large livers.

After graduating from the University of Minnesota school of pharmacy in 1929, Theodore Rowell settled in Baudette, Minnesota, near the Canadian border. When not working in his drug store, the young druggist was studying the burbot in his home-made laboratory. (The burbot is the only freshwater member of the cod family)

Soon after Rowell became interested in burbot and vitamins, an investigational report of the United States Bureau of Fisheries stated that, in experimental tickets, oil made from burbot livers was from three to four times as potent in vitamin D and from four to ten times as potent in vitamin A as good grades of cod-liver oil.

Working in his laboratory, Rowell learned that the liver of the fish made up 10 percent of its body weight and was proportionately about six times larger than livers of other northern freshwater fish. From 1931 to 1933 he worked on different methods of extracting the oil from the liver cells of the fish. After much experimentation he perfected a process that yielded amounts of oil equal to 40 to 60 percent of the liver's weight

Rowell's next step in producing freshwater vitamins was to evaluate burbot-liver oil as a vitamin-provider. Several litters of silver foxes served as "guinea pigs" for further experiments. For two years all foods containing any amounts of vitamins A and D were eliminated from the feeding chart and burbot-liver oil was substituted. The results were very gratifying.

EVEN better were the results of a study of the anti-rachitic factor in hurbot-liver oil recently completed by Dr. Thomas Myers, instructor in pediatrics at the University of Minnesota. In order to test the anti-rachitic value of vitamin D as it occurs in burbot-liver oil, Dr. Myers selected 50 infants from one to two months old from a welfare clinic. Each was given a daily dose of ten drops of burbot oil. Dr. Myers found that, during the observation periods of six months to one year, the children made normal gains and developed satisfactorily in all cases. In no instance did any cases of definite clinical frickets develop.

A Local Druggist in a Minnesota Village Finds that there is Opportunity Outside the Crowded Cities and Develops an Industry Where He Lives

By E. J. FORTIER

His experiments had proved to Rowell that burbot-liver oil was six to eight times more potent than good grades of medicinal cod-liver oil. He also found that burbot oil has a very low viscosity and is more rapidly digested and assimilated than most fish-liver oils.

Early in 1935 the young druggist built a small factory near the shore of Lake of the Woods and launched in earnest the production of the new fish liver oil. Burbot-liver oil was introduced to the medical profession in September 1935,



A rather large burbot. Above it in a jar is a burbot liver proportionate to its size and, at the right in another container, the amount of oil that can be extracted from such a liver



Rowell in his home-made laboratory when hurbot provided only a hobby

and soon after was accepted by the council on pharmacy and chemistry of the American Medical Association.

Burbot are caught in the fall and early winter months when they come to shallow shore waters to spawn and feed. Each of 25 to 35 fishing crews on the Lake hires an extra man whose sole job is removing burbot livers. From 40,000 to 50,000 pounds of vitamin-providing fish are caught daily throughout the season.

The general steps in the Rowell process of manufacturing burbot-liver oil are, first, placing the livers in a large steam kettle in which high steam pressure breaks down the oil cells and frees the vitamin-laden fluid. Next, the oil is rendered and decanted and run into a cooling chamber which is kept at a low temperature until all the stearies have been precipitated and strained off. The oil, after being processed, is ready to be bottled and capsuled without being concentrated or blended.

The small factory on Lake of the Woods is the only place in the United States where burbot-liver oil is produced for commercial use. Moreover, the Rowell factory produces the only fish liver oil of which production is entirely controlled within the United States.

Fishermen are anxious to catch burbot for sale to Rowell not only to supply the new market but also because keeping down the burbot population will conserve game fish on which the ferocious burbot feed.

The amount of burbot available for production of vitamin-rich oil is inestimable. The fish are found in lakes and streams from New England and the Great Lakes region west to the upper Missouri and Columbia River basins, and north to the Arctic Ocean.

Burbot-liver oil has been discussed technically in an investigational report of the Bureau of Fisheries, Washington, D. C., also in *The Journal-Lancet*, Minneapolis, Minnesota

World's Biggest Meat Market

WCH of romance has been written about the famous milhon-acre King Ranch which spreads its broad tracts through southern Texas until it touches the Gulf shore. Yet romance of the garish western plains variety has little place in this "World's Biggest Meat Market," which each year sends 15,000 to 20,000 head of fine cattle to beef-packing centers of the nation.

Rather, it is a story of patience combined with the ingenious application of scientific data and methods. These alone are responsible for the steady growth, improvement, and prosperity of this vast property. The facts comprise an interesting story—an imperishable tribute to the King and Kleberg men, keen-eyed and

The ranch house which is headquarters for the vast Texas domain that is the King Ranch

keen-minded rancher businessmen who in three generations established and developed the nation's greatest beef-cattle production unit. Robert J. Kleberg, Jr., president and general manager of the King Ranch, Inc. is a grandson of famed Captain Richard King who founded the enterprise in 1852 as the very first planned cattle ranch in the United States. All true cattle-ranching activity in this country grew from King's early work.

The property had and has nothing in common with the general agricultural expansion to the west Grain farmers spread out from the east, clearing and developing more and more new territory until they had opened a continuous farming country from the east coast to the Famed King Ranch, America's First Planned As Such, Claims Title To Scientific "Firsts" . . . Its Organization Is Tribute To Man And Machine

By W. P. ELLIOTT

middle west, but the King Ranch is the result of no growth or westward movement; rather, it was deliberately selected out of the middle of a semi-tropical wilderness, isolated from city and village.

lage.
The original purchase consisted of 69,000 acres now known as the Santa Gertrudis division of the ranch, Captain King was aided in his first selection of

land by his friend, General Robert E. Lee. Much of the original purchase was in the natural sod of the torud coastal plains and, even then, stubborn mesquite growth had begun its inroads

Of course, modern transportation and refrigeration were unknown, so only non-perishable commodities such as tallow and hides could be produced. At Captain King's death, the late Robert J. Kleberg, Sr., who had married the original owner's

daughter, became general manager. More land was acquired, although the owners knew that this was not the real answer to the irksome problems which already had begun to manifest themselves. Heavy losses were being suffered because of the deadly fever ticks, screw worms, and many other parasites which externally and internally attacked the great herds of cattle. These were added hazards for, first of all, the range cattle were far out of their climate element. They couldn't stand the extreme heat.

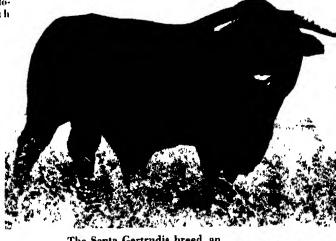
THUS, several decades ago, King Ranch owners summarized their problems and their goal as: 1, To provide dependable supplies of water; 2, To secure adequate transportation to big markets; 3, To eradicate fever-bearing ticks, 4, To develop a breed of cattle able to withstand heat and disease; 5, Land improvement through eliminating standing and running mesquite which threatened the entire ranch, and establishment of a range grass which would thrive despite drought and provide nourishment adequate to carry cattle and bring them to a

marketable weight in short

To reach this goal meant much scientific study. The King Ranch then began itremarkable series of "firsts" by dipping cattle to eradicate the fever tick. Abundant supplies of water were secured through the

initiative of Robert J. Kleberg, Sr., in drilling the first artesian well in South Texas, discovering underground water stocks on which hinged much of the later ranch and farm development of the area. There still, however, was no answer to the heat problem. Many sheds were built to shelter the stock from the broiling sun, but cost and enormity of the project made the method prohibitive.

Then from far-off India came the answer—the Brah-



The Santa Gertrudis breed, an important scientific contribution to cattle raising: first breed developed in America

A simple yet important innovation: smooth wire fencing instead of barbed wire which often slashes range cattle badly



ma bull. Brought to the ranch 18 years ago was a gift bull sired by a Brahma out of a shorthorn cow. This was the foresire of the famous "Santa Gertrudis" breed of cattle. The ranch had begun, long before, to cross-breed shorthorn and Hereford bulls with common range cattle, finally breeding them pure. The cattle were good for feed lots-for someone else to feed and mature-but they had lost their hardiness, their resistance to insect pests and their ability to fatten. The cross-bred Brahma bull, upon its arrival at the ranch, was pastured with 3000 unregistered, pure-bred shorthorn cows, along with other shorthorn bulls. From all the calves therefrom, 60 of the best females and one bull calf were selected as the finest beef calves in the range's history.

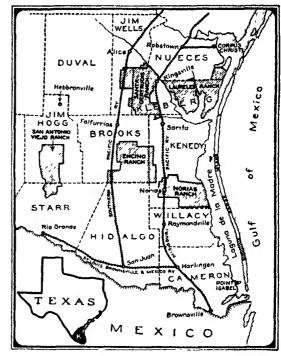
Fifty-two Brahma bulls were immediately purchased and the process of selection, line breeding, and inbreeding was scientifically continued. A great sire was developed, and at length, the famous bull, "Santa Gertrudis," was bred, representing near perfection. This great bull is head of the King Ranch herd now.

Today, steers of the ranch calf crops average from 100 to 200 pounds heavier at one year of age than Hereford and Durham cattle and are carried to marketable weight in the shortest length of time. They withstand drought well. The obstacles of heat and disease have been decisively licked. The ranch gets credit for one of the most progressive steps in American animal breeding history—a veritable milestone in the cattle industry. It was another "first" for the Klebergs.

The Missouri-Pacific railroad, in 1900. had solved the major transportation problem, so that only one remained—more and better pasture for the rapidly

growing herds. In the closing years of his life as a great builder Robert J. Kleberg, Sr., often said that, if he had his work to do over, he would improve the land he owned rather than purchase more and more land for expanding herds. The demon mesquite annually was taking more toll of valuable grazing land. At first, Mexican hand labor was used in an attempt to clear the land. The original owner had given employment to all who came seeking it, but the results were costly and the progress was slow.

In spite of cost and bad times, the ranch management continued to use hand labor, although clearing represented six man days per acre! To feed and employ men liberally was all well and good but it was not getting the job done that



The several large ranches comprising the King Runch holdings. Note section on the Island. Inset map of Texas shows (K) general location



The "tree-dozer" showing, in small picture, the pusher bar and the heavier cutting edge beneath it. Below: The machine rips into large growth with no great effort

had to be done. Young Bob Kleberg then tried wheel tractors equipped with winches to yank out the stubborn mesquite, but with little success. So he put his head in his hands, sharpened up his pencil, and did some serious and scientific thinking, possibly remembering that his father long before had visualized a steam plow in the realization that successful clearing operation would require a machine that could move right along in continuous operation. He sketched a great pushing, ripping, cutting tool which would

literally tear the heart out of the mesquite jungle, leaving it clear for the planting of palatable grass food for his herds. What power, however, could pull or push such an implement? The job required not only power but traction—something that could crash through the tangle, push over trunks two feet in diameter, disregarding uneven or soft footing.

The rancher then thought of the tracktype tractor and decided the most powerful model might do the trick. He called upon the distributor at San Antonio who handled "Caterpillar" Diesel track-type tractors This company and allied manufacturers studied Kleberg's description and sketches and devised what came to be known as the "tree-dozer."

This implement, mounted on the front end of a 95-horsepower Diesel tractor, consists of two independent parts. One is a pusher bar carried ahead of the tractor's nose, arranged so that it will strike the tough mesquite trunk from 1½ to 7 feet above the ground. The other

part, just below the pusher, resembles a bull-dozer. Three feet high with a heavy, keen cutting edge, the bull-dozer adds the "two" to the "one-two" punch delivered by the unit. Both parts are sturdily mounted and either hydraulically or cable driven by the tractor operator.

In operation, the tractor plunges into heavy mesquite. The pusher bar strikes

power—pulling power—the ingenious rancher concluded, and he proceeded to devise another tool, a heavy ten-foot blade to be drawn eight to ten inches under the ground and parallel to the surface, the blade to be supported by uprights fixed to a heavy bed. Again the tractor distributor and allied equipment makers aided, and the "knife rooter" was born. The implement required plenty of



The "knife rooter": a powerful tractor draws a heavy ten-foot blade several inches under the surface of the soil to cut off the roots of, and destroy running mesquite

the trunks first, bending them forward and exposing the roots. The cutting edge below "follows through," striking at the roots of the bent mesquite and quickly gouging out the growth.

How effective this unit is can best be told by the following data:-The first Diesel track-type tractor and tree-dozer delivered to the ranch has worked 6700 hours and has cleared considerably more than 10,000 acres of hitherto mesquitetangled land of low economic value which now is seeded in nourishing, hardy Rhodes grass. It is thought that approximately 80 percent of this clearing is permanent or results in 80 percent destruction of brush growth. Use of the treedozer is expected to cheapen costs of clearing but it is early to place an exact cost figure because of varying local conditions and size of jobs. The cost of operating the tree-dozer alone on the King Ranch jobs, including low-priced Diesel fuel, lubricating oil, operator's wages, and depreciation has amounted to only approximately \$1 40 an acre.

STANDING mesquite, however, is only half the problem. During the last few years, there has been a rapid encroachment of "running" mesquite onto what had been good pasture land. Of small diameter, this energetic native brush of the Texas gulf coast reaches a height of from six inches to four feet. Its tough root system masses to choke out the grass, and the brush often contains more growth underground than above.

Here was a job that also called for

power and again the 95-horsepower Diesel track-type tractor was called upon to pull the tool.

Success again smiled. The outfit was able to destroy two acres of running mesquite an hour. This rooter equipment, used in conjunction with the tree-dozer, results in complete destruction of all brush. The ranch let this job to a contractor who will clear 25,000 acres per year for the next four years. The ranch will continue to clear land with the tree-dozer and seed it to five pounds of homegrown Rhodes grass seed per acre.

And so the last of the King Ranch's major problems was solved. There are other "firsts" to the credit of the ranch, and it may be well to list some of them, for they have contributed immeasurably to southwest ranching: First cattle ranch in the United States. First ranch to kill fever ticks by dipping cattle. First and only ranch in the United States to develop and bring to perfection a distinct breed of cattle. First ranch to provide a range grass that would withstand heat and drought. First to abandon the use of barbed wire and to substitute smooth wire fastened to posts without the use of staples. First to invent the humane and efficient electric prod for handling cattle. First to develop and use the treedozer and knife rooter to clear mesquite ridden land.

Kleberg, Jr., has made no secret of his experiments and the results are available to ranchers throughout the world.

Fellow ranchers along the Rio Grande valley are already adopting his land-

clearing methods and following his advice in stockbreeding, care and feeding. They are warm in his praise, declaring that he has done more than any other individual to advance cattle ranching, and all in the face of great odds.

King Ranch, Inc., at present consists of five divisions, each under direction of a superintendent and totalling approximately 900,000 acres over which graze 50,000 head of beef cattle. These divisions employ approximately 450 Mexican laborers. Headquarters, where the beautiful ranch house is located, is Santa Gertrudis. On this tract a purebred Jersey herd supplies milk free to employees of this division and to former employees now living on pension in nearby Kingsville.

SUCCESS of the large enterprise is attributed freely to the co-operative work of the management personnel which acts as a smoothworking team. Each man is responsible for certain definite work but each also brings his contribution to the solution of any problem that may arise Chairman of the board is Richard M Kleberg who represents his district in the Congress of the United States. Robert J. Kleberg, Jr., is president and general manager. Caesar Kleberg is assistant ranch manager. Alice G. K. Kleberg is secretary and treasurer and A. L. Kleberg is office manager and secretary. Tom East is head of the sales department General superintendent of farming is Worth Wright and ranch division superintendents are Charles Burwell at Laureles, Lauro Cavazos at Santa Gertrudis, Jim McBride at Encino, Tom Tate at Norias, and Tom East, Jr., at San Antonio Viejo.

Important job of chief veterinarian is held by Dr. J. K. Northway who is in charge of the dairy herd and who supervises medical care and breeding of all herds. The ranch raises its own horses, and every horse used by the ranch cowboys is an offspring of the Mexican quarter horse and the English thoroughbred.

Selective breeding is all done on the headquarters division. Breeding cows and bulls raised there are supplied to the other four divisions. At present there are approximately 40,000 breeding cows with one bull to each 50 cows.

Small wonder the beginnings of this magnificent property have received more than their share of romantic writing. It would seem, however, that there is more romance in the struggle for existence and financial success—in overcoming with science and ingenuity those obstacles, any one of which could have meant oblivion to the clan of King-Kleberg as great ranchers.

To this belief the many thousands of sleek, dark red cattle with those strange humps reminding one of the Orient, grazing in many herds and disdaining the blazing sun, give eloquent testimony.

Problems

Are Scientific American Readers Interested in Mathematical Problems? To Settle this Debated Question The Editors Offer These as a Test

By LEONARD KAPLAN
Lieutenant Commander (CC) United States Navy

To the average human being a problem, like an unsolved puzzle, stands as a challenge. "Ha! you can't solve me," the problem seems to jeer, while the human being replies: "Are you positive? And just to show you how very mistaken you are, I am also going to solve you—and now." And solve it he does—well, maybe!

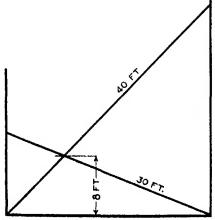
The five problems on the present page are offered by one of the United States Navy's builders of battleships whose recreation in off hours is this kind of sport. No prize is offered for their solution; they are presented merely because many readers like to tussle with something a bit tough. The answers, but not the solutions, are given on page 251. Of the two, the solutions are of course the principal factor, though for lack of space these cannot be published-some of them are rather lengthy. However, in case of heavy interest in any one of them the question of publication of the full details of solution will be reconsidered.

Whether you find these particular

problems dead easy, plain easy, average, a bit difficult, or very hard, will naturally be a matter of relativity: that is, whether you happen to be a mathematician, a mathematician of sorts, or are a creaky mathematician (many a former good mathematician, alas, has found that, when not actively paed for a few years, his once bright and shining classroom schooling in mathematics apparently has oxidized a bit). However, the tougher the problem the more satisfaction in cracking it. The "Problem of the Crossed Ladders" will require algebra, the "Problem of the Spheres" can also be solved by algebra, the "Problem of the Barge on a Rock" requires "trig," and both of the "Dog and Rabbit Problems" will necessitate use of the calculus.

Problem addicts are requested to address their entire problem correspondence direct to the author, in care of this magazine, but kindly not to the editors who, with a magazine to get out each month, have pressing problems of their own—The Editors

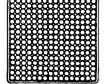
The Problem of the Crossed Ladders: Two ladders, one 30 feet long and the other 40 feet long, rise to oppo-



site sides of an alley lined by vertical walls, and intersect (in projection) at a point eight feet above the ground, as shown in the drawing. How wide is the alley?

The Problem of the Spheres: A

receptacle infinitely large is filled with spherical balls one inch in diameter. What proportion of the space within the receptacle will be occupied by the



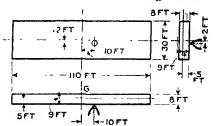


balls and how much will be void, assuming that the balls are stowed as compactly as possible [shaken down.—Ed.]? What will be the proportions if half-inch spheres are substituted, as shown?

The Problem of the Barge on a

Rock: A barge of rectangular section throughout, having the following dimensions: length 110 feet, beam 30 feet, depth eight feet, is floating on an even keel at a draft of five feet, with the center of gravity nine feet above the

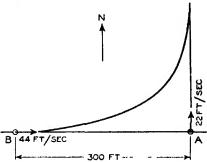
base. The barge touches upon a rock ten feet forward of the middle length and two feet outboard of the center line. The tide then falls six inches. Find the drafts at the four corners of the barge and the



pressure upon the rock in this condition. (Assume salt water 35 cubic feet per 2240-pound ton.)

The Dog and the Rabbit Problem:

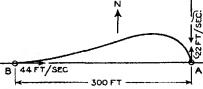
A rabbit runs northward from a point A at a rate of 22 feet per second. A dog, starting from a point B, 300 feet west of A, at the same time, runs on an ever-



changing course directly toward the rabbit, at a rate of 44 feet per second. How long will it take the dog to catch the rabbit? How many seconds after starting will the dog be headed northeast?

Second Dog and Rabbit Problem:

A rabbit runs northward from a point A at a rate of 22 feet per second. A dog, starting at the same time, from a point B, 300 feet west of A, runs directly to-



ward the rabbit at a rate of 44 feet per second. Assume now that the rabbit, after having run some distance north, sees the dog, reverses his course suddenly and runs south at the same rate of 22 feet per second, the dog meanwhile continuing to run at a rate of 44 feet per second directly toward the rabbit. How many seconds will have elapsed from the starting time to the time when the rabbit changes course, if both the dog and the rabbit are to arrive simultaneously at the original starting point A? In what direction will the dog be headed at the moment the rabbit reverses his course?

(Answers on page 251)

Berenice's Hair

N a clear spring evening, when the Pointers have passed the meridian, and the middle of the Dipper is high above the Pole Star, one may see, high up, and south of the zenith, a cluster of faint stars. Individually, these are far from conspicuous; but there are enough of them to catch the eye if the night is dark. Moonlight drowns them out almost completely.

Star gazers seem to have had an eye for such groupings, even though faint, for this insignificant group has had a name of its own and been recognized as a constellation since classical antiquity. It is known as Coma Berenices—Berenice's Hair Alone among the ancient constellations, it commemorates a historic individual—Queen of Egypt in the 3rd Century B. C.—yet the name was generally adopted, and Catullus, 2000 years ago, wrote a mock-heroic poem in honor of this parvenu in the celestial spacesprobably itself a translation from an older Greek original.

The astronomer of the present day has a human, but not a professional, interest in these ancient tales; but the constellation itself has plenty to interest him. Like every other, it contains stars of individual interest-double, variable, and the like; but its appearance naturally arouses the inquiry: Is this a mere accidental conglomeration of unrelated stars, some of them far more remote than others, or a real cluster of objects at about the same distance, and of common motion and origin; or have we a real cluster, mixed up with other stars, in front of it and behind?

From what we know in other cases, the last would be the best guess. A number of star-groups, most of them recognized and named from antiquity, are now known to contain stars which are really related to one another-the Pleiades, the Hyades in the head of Taurus, Orion, the Great Bear (our modern Dipper), Scorpio, and the Southern Cross. But in all of these except the first, some of the most prominent stars belong to the foreground or background, and not to the true cluster. There are, however, other groups, almost as promising in appearance, which prove to be mere chance collocations-such as the pretty semicircle of Corona Borealis, or the great cross of Cygnus.

To distinguish one of these situations from the other, and to pick out the real cluster-stars from the interlopers, is sometimes casy. The naked-eye stars of the Pleiades, for example, are appar-

Recent Research Proves That This Nearby Cluster of Stars Is No Mere Accidental Conglomeration of Unrelated Bodies but Is an Interrelated System

By HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

ently moving in the heavens in very nearly the same direction, and at almost the same rate, so that there is no more reason to doubt their real connection than in the case of a flock of birds flying together across the sky. The same is true of many, though not all, the stars of the Hyades. Aldebaran, the brightest of all, is moving faster and in quite a different direction, so that it clearly does not belong to the group.

We can thus pick out, and omit from our counts, many of the aliens; but, though this test often affords a conclusive ground for exclusion, it is obviously not a perfectly safe test for admission. Among the many stars in the large region of the sky covered, for example, by the Hyades, there are likely to be a few whose proper-motions, by mere chance. happen to agree closely with that of a cluster star. Even when allowance is made, as is necessary in this instance, for the perspective effect of apparent convergence of the really parallel motions of the cluster-stars, a chance coincidence is still possible

TO weed out these strangers, we may have recourse to the radial velocities. spectroscopically determined The real cluster stars must be moving togetherthis is, indeed, the physical definition of the cluster. Hence they will all be approaching us (or receding from us) at the same speed (apart from perspective effects in a very widely scattered group). The great majority of the stars which show substantially the same proper-motion should therefore have the same radial velocity. Those which disagree by more than a reasonable allowance for the small errors of measurement must again be rejected—they have passed the first selecting screen, but not the second We must be a bit careful here, for a star may be a spectroscopic binary, with orbital motion of its own. Repeated observations will show changes in the velocity as it moves around its orbit; and, if they are kept up, will make it possible to calculate and allow for the orbital motion-when

the original test is applicable to the remaining motion

There is still a third test. The stars of a real cluster can not differ greatly in distance from us -unless, indeed, the cluster itself happened to be an elongated cigar-shaped affair pointed directly at us, which is too improbable to bother about. For such practically equidistant objects, the differences in apparent brightness will reproduce those in real brightness-if one star is ten times as bright as another, it will look ten times as bright. When the apparent brightness (stellar magnitude) of the cluster members is plotted against the spectral types. a diagram of the familiar sort is obtained. Ordinarily, the bulk of the stars belong to the "main sequence" in which the redder stars of "later" spectral type are increasingly fainter, the redder they are. There are sometimes, though not always, a few bright red stars which really belong to the cluster, and are "giants" Ostensible cluster-members which fall outside these two classes are suspicious. Those which pass the proper-motion test. but fail here, usually fail also when the radial-velocity test is applied, and do not belong in the list at all. The chance that a star would, by sheer luck, get by all three of these tests is small enough to give us little concern (unless, indeed, we have thousands of probable cluster members to deal with-which has not yet happened).

This last test has another value. There are several clusters for which the distances of the stars may be found, reliably, but in ways of which there is no space here to speak. In these cases the real brightness of the stars can be found from their apparent brightness; and it then appears that the real brightness of a main-sequence star of the same spectral type (say G0, like the Sun) is closely the same in all the clusters-and also among the individual stars, nearer the Sun, for which we have good parallaxes. This means that stars similar in spectrum are at least pretty closely similar in brightness, and presumably in other properties.

If the same is true in other clusters, we can find their distances by comparing the apparent brightness of stars belonging to them with the real brightness corresponding to their spectral types. It is, of course, necessary to be sure that we are dealing with main-sequence stars, and not with the far brighter giants; but the diagrams already described make it clear that this can almost always be safely done.

A detailed, careful, and very convincing study of the cluster in Coma Berenices has recently been made by Dr. Trumpler of the Lick Observatory, who has already investigated many other clusters. Though known from antiquity, this cluster presents a peculiarly difficult problem. Its stars are fairly bright, but their proper motions are small, and in the direction of the general apparent drift produced by the Sun's motion in space. The unrelated stars are more likely to show apparent motions of this sort than of any other. Hence, though many of them will be rejected by the proper-motion test, the number which get by will be larger than for other clusters, and a list based on this test alone will contain non-members. The radial velocity, too, is small, and near the average for all the stars, but this test suffices to reject the majority of the stars which have sneaked into the first list. When the third test is made, by plotting the apparent magnitude against the spectral type, a few cases where both the other tests must have been passed by chance are revealed; and the remaining, thrice-tested list, should be trustworthy.

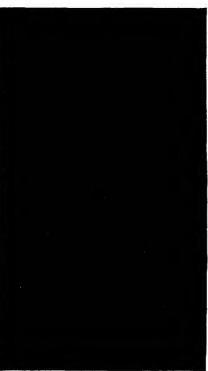
To secure this result, all three tests have to be worked for all they are worth—and the account of the way in which this was done fills most of Dr. Trumpler's 28 large pages.

There is plenty of material for the proper motions, but the various sets of observations by nine different observers had to be most carefully compared. The minute systematic differences which are always to be found between the results of even the best work with different instruments and methods were carefully determined and allowed for, till, at last, a homogeneous set of results was obtained, representing the final result of more than a century of observations with the meridian circle, and 60 years' photographic work.

When these motions were plotted, those of a dozen or more of the brighter stars were so nearly identical as to make it certain that a moving cluster really existed. The fainter stars showed a group with this same motion, but more doubtful cases—as well as still more to be excluded.

The radial velocity test came next. Twenty-one stars had already been observed, at various places; 47 more were added by special observations at the Lick. Most of these stars are faint, and a great deal of work had to be done to get the three spectra per star which are needed to weed out variable velocities and get good average values.

To get uniform material for the third test, the photographic magnitudes of many of the stars were determined by new observations, and the results of earlier observers were re-discussed and combined with these. Most of the spectra were already given in the great Henry



The constellation Coma Berenices, photographed by Edward E. Barnard at the Yerkes Observatory.

In his text Professor Russell mentions the origin of this odd name for the tiny constellation. In more detail the story is that Berenice was the wife of Ptolemy Euergetes, of Egypt, who reigned about 250 B.C. She was a blonde and she vowed that if her king, who had gone over to Babylon to fight a war, came back victorious, she would cut off her tresses of amber and place them in the temple of Venus at Zephyrium. The Ptolemy won his battle and the lady really made good her promise, but somebody stole the hair from the temple! The Astronomer Royal, a diplomatic man, thereupon jumped into the breach and named this cluster of stars Berenice's Hair, so Berenice had hair again

Draper Catalogue, but 18 faint stars were specially observed at Harvard to make the list as complete as practicable.

When all this mass of work had been done, it was at last-possible to apply the three tests with the new, homogeneous data, and be sure of the significance of the results.

Out of an original working list of 212 stars, and an additional one of 21 fainter

objects deserving investigation, 37 stars passed all three tests—leaving no doubt that a physical system of stars with common motion is really present. Seven fainter stars, for which radial velocities were not easily to be observed, pass the other two tests, and probably belong to the cluster. They are widely scattered over the sky, in a circle 7 degrees in diameter—making this one of the largest of all clusters as regards apparent size.

The brightest cluster star is of magnitude 4.8, and there are five others brighter than the sixth magnitude. Five other stars, in the same region, and above the same limiting brightness, have nothing to do with the cluster.

The proper-motion of the cluster is small, 0°.021 per year. Its parallax, determined by comparison of the real and apparent brightness of the cluster stars. is 0°.013, making the distance 75 parsecs, or 250 light-years. The real motion in space is in almost the same direction as the Sun's and at two thirds the velocity, so that the Sun overtakes it at the unusually small speed of 7.5 kilometers per second. The outer diameter of the cluster is about 30 light-years. The brightest star in the cluster is 50 times as bright as the Sun. The faintest which have so far been identified has about 1/30 the Sun's brightness. All the stars but two belong to the main sequence, and have spectra ranging from A0 to K2 The rate of decrease of brightness with increasing redness is very similar to the average for other clusters. The two giants are of unusually early types, A8 and F4.

The cluster is a "poor" one, containing less than 50 stars; but this is nothing remarkable, for nearly half the more distant galactic clusters which have been recorded in Trumpler's work are no richer. In its central part, stars brighter than one fifth the Sun's light are, however, more than 50 times as thickly strewn in space than in the general field outside, so that it is a very real affair. Indeed, calculation shows that the mutual attraction of its members should suffice to keep them together—though by no very wide margin. Compared with a rich cluster like the Pleiades, Coma Berenices shows a smaller proportion of faint stars. Whether this is true of other poor galactic clusters we do not know—they are too far off.

TWO incidental characteristics may be mentioned. This is one of the nearest clusters—only the Hyades and the Ursa Major group being nearer; and, as we see it, it is about as far as possible from being "galactic," since it lies within a few degrees of the north pole of the Milky Way. Its distance, in space, from the galactic plane is not abnormal. We are so close to it because we are—so to speak—right under it, which accounts for its apparently unusual position.—Princeton University Observatory, February 5, 1939.

INSECTS CANNOT WIN

T seems to be the general impression that insects are more numerous and troublesome today than they were during our youth. Is this true? Yes, and no. Some insects are more numerous and troublesome. For example: grasshoppers, which were long but a legend to us-a legend of the pioneer days in the Dakotas, Nebraska, and Kansas, those days when the sod-hut settler was driven from his claim by the vast hordes of Rocky Mountain locusts that swept into his fields and left no single green thing. It is also true that many new pests have come into prominence during the present generation. We have seen the coming of the European corn borer, the Japanese beetle, and the white-fringed beetle, the last so new that it is not known to the general public but is only too well known to the farmers in a small area in northern Florida and southern Alabama.

IT is not true, however, that most of our insect pests are remarkably more numerous than they were during the last generation. They are merely attracting more attention. The last generation accepted worms in apples as a normal state of affairs, and gouges in the side of potato tubers occasioned by white grubs and wireworms were expected The early canning industry and the consuming public paid little heed to fragments of insects in canned goods. They could not be seen and were, therefore, "not present." Today we have a very discriminating public. An apple pack must be absolutely free of insects, and the canner is very carefully watched by health authorities to see that no insect fragments, even though discernible only with a microscope, shall be in the can that reaches the consumer. What was considered a very satisfactory crop a half century ago is nearly crop failure today, with exactly the same amount of insect damage. The rôle of insects as factors in human diseases and diseases of livestock has attracted very considerable attention. Even many plant diseases are carried by insects. Our public has also been made very insect-conscious by the press, the radio, and the motion pictures. The layman knows that insects can be controlled and therefore insists that they must be controlled.

Will insects eventually destroy man? Not without some vast change in this earth on which we live. Quite true, they are capable of multiplying at a rate that is astounding. The progeny of a single pair of aphids, if they all lived, reproduced, and their offspring lived for one

Civilization's Unnatural Balance Cause of Apparent Victory . . . Most Insects Are No More Numerous, Only More Notorious . . . Many New Insecticides

By LEE A. STRONG

Chief, Bureau of Entomology and Plant Quarantine,
U. S. Department of Agriculture

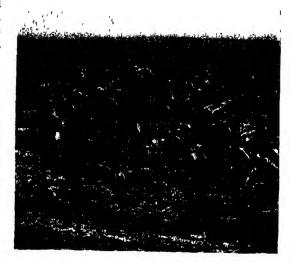
entire year, would fill up the Atlantic Ocean with their bodies. But this does not occur. Nature is a beautifully balanced machine; not static, but slowly progressing, first with one group being dominant, then another. The giant reptiles had their day millions of years ago. Then the changing earth gave the mammals an inning in the Tertiary period. But during this time, and long before, the insects were maintaining themselves in very similar conditions and even in very similar form to the insects of today.

In the primitive jungles of the tropics insects occur in countless numbers and

kinds, but vegetation and primitive man live with them. That is the keynote of the whole situation. Primitive man, primitive conditions, all nicely balanced; but civilized man promptly destroys that balance. He introduces the plow. He cultivates large areas of exotic plants. He brings in livestock. New adjustments must necessarily take place These adjustments, however, take thousands, even millions, of years and man cannot wait. In order to maintain this unbalanced situation that he must maintain with his present civilization, he must strike

an artificial balance and he does this by, in one way or another, making his cultivated fields and domestic animals an unsuitable environment for the insects.

Probably one of the greatest advances in the control of insects was the discovery that arsenic, then in the form of Paris green, was very poisonous to insects. New arsenicals were discovered in rapid succession. The boll weevil that crept across the Rio Grande late in the 19th Century threatened to wipe out an entire civilization built up around the production of cotton in our southern states. This insect is adequately controlled by dusting with



A healthy (though not very luxuriant) field of corn before it was attacked by grasshoppers. A fair crop might have been expected from it



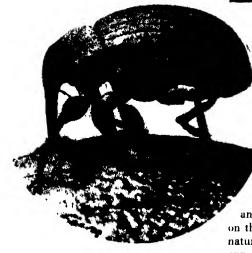
The same field as that shown above, after grasshoppers had feasted on everything but the hard-skinned stalks. Such grim reminders of the appetites of hordes of insects have caused apprehension, in the minds of many, as to man's ability to defeat the insects

calcium arsenate. But, to illustrate how easy it is to upset the normal balance, the application of this calcium arsenate, in addition to destroying the boll weevil, destroys a number of insects that feed on the cotton aphid; and often the application of boll weevil control methods is promptly followed by serious outbreaks of the cotton aphid.

The last half century can almost be called a chemical age. The science of chemistry has advanced so rapidly that there is hardly an activity of man that today is not stimulated and in some cases made possible by the work of the chemist. This great development of chemistry has



Cotton picked from two plots of ground of equal size. Yield on the left is from the unpoisoned plot; that on the right from poisoned plot. The poison kills the boll weevil, shown greatly enlarged at left



also vastly improved our methods of attacking insects, and today large numbers of highly trained chemists are working in the Federal Government laboratories at State experiment stations, in private insecticide companies, and individually on the improvement of munitions of war used in our battle with the insects.

Of course many insects do not lend themselves to control with chemicals and many of our most successful methods of combating these pests have been along quite different avenues of attack We control the hessian fly with our knowledge that this insect emerges at a very definite time with relation to climatic conditions. With this knowledge, we plant our wheat after the flies have emerged and died. We know that certain bark beetles-those pests which destroy more timber in any year than do the dreaded forest fires and which, in addition, are the predisposing cause of many of these fires because the insect-attacked forest with its tangle of fallen trees is a very potent factor in these great conflagrations—can be controlled, if discovered in their early stages, by simply felling infested trees and removing the bark or otherwise destroying the brood of bark beetles.

Another very important line of attack is our attempt to re-establish the balance in Nature's battle. This method is particularly applicable to insects brought to

this country from foreign lands. In the land of their origin. these insects have an established balance. They are preyed upon by other insects, they are attacked by disease; they are fed upon by birds and mammals, and do not multiply in the devastating hordes that they do when they reach the land of the free-free of all their enemies and diseases. By studying these insects on their native heath, we discover these natural enemies and introduce them into our own land. Early in the citrus industry of California, the cottony cushion scale was introduced from Australia and grew "bigger and better" in the land of perpetual sunshine. An entomologist was sent to Australia to look into this matter. He found a little lady-beetle, the Vedalia, and brought it to America, the cottony cushion scale is no longer a pest in the

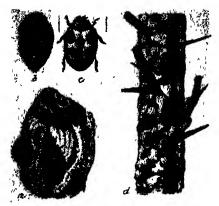
HERE, however, we will direct our attention to the control of insects with insecticides. This is no simple matter. It is not merely the discovery of a poison that will kill insects and then its application to all insects. That there are now estimated to be 624,300 different insects in the world, that in our own country we have records of over 20,000 different kinds of insects that are of some economic importance and over 6000 of these are actual pests, is not generally known. These insects have a great diversity of form and habit. They can live under almost any conditions found in Nature. Insects live in crude petroleum wells; they live in saturated salt solutions; they live in springs hot almost to the boiling point; they live on the most barren deserts; they live long periods of their lives under water. They feed in many different ways; they breathe in many different ways; they reproduce their kind in many different ways. All of

citrus groves of California.

these diversities require differences in treatment. A young mosquito lives in water, and any attempt to kill mosquitoes that are flying about the house is almost wasted effort. These insects, while in the water, breathe through a tube in the tail that is thrust above the surface. Hence an approved method of control is to separate this tube from the air by placing a film of oil on the water.

Plant lice, the chinch bug, all our scale insects, cannot be poisoned by placing poison on their food, as they do not feed that way. These insects have their mouth parts developed into a sucking tube which they thrust through the poison and into the unpoisoned plant tissue beneath. These must be killed with an insecticide that will destroy them by coming in contact with their bodies, or by a gas that will enter their bodies by other methods than through the digestive tract. Some insects are attracted to certain substances. These insects can be killed with poisoned baits. Others are repelled by certain substances, and crops are protected by applying these repellents. Each insect, by its peculiar habits, requires either a modification in the insecticide used or in its method of application.

Another factor that further complicates the problem is the changing standards of human welfare. For many years, arsenicals were standard insecticides. Then it was discovered that quantities of these poisons, believed to be detrimental to health, were being consumed on foodstuffs that had been treated with these insecticides, and prohibitive legislation against such foods made it necessary for the entomologist to start his attack anew. Certain other insecticides were not compatible with fungicides that were being used on the same plant for the control of the fungous diseases, and modifications or new insecticides were found necessary. The early work was largely with the inorganic chemicals as base materials in developing insecticides. We are now rap-



Imported from Australia, the Vedalia beetle, c, destroys the cottony cushion scale, on twig d, also a native of Australia. Beetle pupae, a, feed on ogg mass of scale. Adult beetles feed on scale on the twig

idly moving into the field of organic chemistry in insecticide work.

Organic insecticides are showing great promise. Most of these substances are obtained from plants, some from cultivated crops, others from forest products, and still others from weeds. Those in another group are built up in the chemical laboratory and are known as synthetic products. Every year, the waste material of the tobacco industry is used to produce about a million pounds of nicotine, which is equivalent to about 2½ million pounds of the commonly used solution sold as nicotine sulfate. This material is one of our most valuable insecticides, having

fish so paralyzed were not in any way poisonous when eaten. The active principle of derris is rotenone, one of the most powerful insecticides yet discovered. It is 30 times more poisonous than lead arsenate to the larvae of the silkworm and when used on aphids it is 15 times as toxic as nicotine. It is so possonous that one part in 13 million parts of water will kill goldfish, and yet is but slightly, if at all, poisonous to mammals-being only 1/100 as poisonous as lead arsenate to rats. This material is almost an ideal insecticide. It is not injurious to plants or animals sprayed or dusted with it. It does not leave on foodstuffs a residue that is poisonous to man or domestic animals, and it can be applied in doses small enough to be economical. In 1937, over 570,000 pounds of derris were imported into the United States from British Malay, the Dutch East Indies, and the Philippines.

In addition to derris, other plants contain rotenone. Of these, devil's shoestring occurs as a common weed throughout the United States—a plant belonging to the bean family which occurs on land so poor that little clse will grow. Research work on the production of devil's shoestring having high rotenone content is now under way. This research may lead to our being self-sufficient in the production of rotenone. A third source of rotenone is a root from Peru and Brazil known as lonchocarpus. Last year we imported over a million and a half pounds of this root for use in compounding insecticides

Oils obtained from corn, cotton, soybeans, linseed, peanuts, and many other plants have been found to have decided insecticidal value. Certain of these oils are more toxic to mealybugs than are the usual petroleum oils used for this purpose. They have a decided advantage over petroleum oils in that they are better solvents for such insecticides as rotenone. It has been found that the addition of soybean oil to nicotine bentonite increases the toxicity of nicotine on apples and thus insures better control of the codling moth. It has also been found that the addition of certain of these vegetable oils increases the toxicity of certain other organic poisons such as derris, nicotine sulfate, and anabasine sulfate

Soaps made from corn oil, cottonseed oil, soybean oil, and other organic oils, possess high insecticidal value. It has been found that the fatty acids derived from plant oils may be used in place of acetic acid in Paris green and the resulting compounds have greater insecticidal value and are less likely to damage plant tissue than ordinary Paris green.

The future of insecticide development is very promising An acid from the cocoanut is the base of a potent insecticide. Oat hulls and corn cobs yield furfural, and derivatives of this remarkable compound have given promising results Sulfur, when combined with other substances found in plant oils, has been found to be quite toxic. Corn, rye, wheat, and other agricultural surpluses may be fermented to produce alcohols which, by proper combination, produce substances of great insecticidal and fungicidal value The day may come when insecticides made from wastes and very cheap products will so reduce the price of insecti cides that that margin on which the farmer lives, often so narrow, will broaden out and lead to a better farm life and, in turn, by reducing the cost of agricultural products, to a better national life.

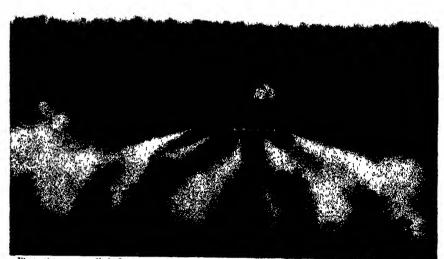


long been known as a fumigant and as a contact insecticide to kill such insects as aphids.

Recent research work has demonstrated that a combination of nicotine with a clay-like substance known as bentonite forms a very effective stomach poison which promises to become a successful substitute for arsenate of lead in the control of the codling moth.

In 1937, nearly 20 million pounds of pyrethrum flowers were shipped into the United States, the great bulk of the material coming from Japan, sizable shipments also being imported from Jugoslavia, Kenya Colony, and Brazil. An insecticide is prepared from these flowers which is the base of many of our most useful fly sprays.

The natives of the East Indies and Malaya have long known that the roots of a plant called derris, when pounded up in water, would paralyze fish and that



llimitrations courtery U. S. Department of Agriculture, Buresu of Entomology and Plant Quarantine

Many tons of poisons are sprayed on the cotton fields of the South every
year by several different methods. Note the cotton blossoms in lower field

World's Safest Ships

Sea Disasters Too Frequent in Recent Years . . . American Ship Lines Attack the Problem . . . New Ships Will Have Vastly Improved Safety Features

By JOHN P. LEE

TEW safety features being incorporated in the S.S. Ancon, recently launched, will make her and her sister ships the Panama and Cristobal the safest ships in the world. These new vessels will be operated this year under the American flag by the Panama Railroad Steamship Line in service between New York and the Panama Canal, via Haiti.

The trio of ships are the first American-built vessels to comply with the safety requirements drawn up several years ago by the Senate Technical Committee on Safety at Sea, headed by Admiral George H. Rock, and the sub-committee on Fire Control, headed by George Sharp, noted naval architect, to assist in the formulation of legislation for use by the Bureau of Marine Inspection and Navigation.

In order to create the circumstances of an actual fire at sca, the experts conducted a long series of tests on an obsolete vessel, the S.S. Nantasket Single staterooms, as well as a group of adjoining staterooms, were built into the old ship. Various materials, including impregnated and untreated wood, asbestos compositions, aluminum, and steel, were used in the construction of the rooms. A space of three feet was allowed between the walls of the rooms and the shell of the ship in order to permit observation from the side.

Portholes were simulated by running vents from the stateroom walls through holes opened in the ship's side. An artificial non-recirculating ventilation system was also provided.

The tests involved three types of stateroom construction: 100ms built of steelfaced panels, with various type cores, of wood impregnated against fire, and of asbestos composition with special steel construction members or by orthodox joiner work methods using impregnated wood or asbestos composition. Some of the rooms were fitted with deck coverings, of various types, both within the test enclosure and on the deck above it.

To create a severe fire, cordwood and kindling, to the amount of five pounds per square foot of floor area, were stacked inside the room and, at a given signal, ignited at several points to produce a uniform spread of flame

Each fire was carefully timed by observers. Temperature readings within test enclosures were made from thermocouples variously located, one near each corner of the room and one in the center

TESTS showed conclusively that walls of substantial construction having panels of incombustible materials stood up without harmful bending or buckling, effectively confining the fire to the compartment they enclosed. Substances such as asbestos compositions, and corrugated and treated asbestos papers, were found suitable for such inner cores, faces of panels being steel, aluminum, or asbestos composition and in some cases with added thin veneers.

Under some conditions it was possible to employ thin combustible panel face vencers, combustible furniture, and combustible decorative trim without impairing the toom's capacity for fire confinement. Fire zone bulkheads or main subdivisions equipped with easily closed fire doors were also developed for keeping flames originating in machinery, cargo, or public spaces from spreading throughout the ship. Further protection against fire, it was found, could be obtained by covering the floors and deck with various type deck compositions.

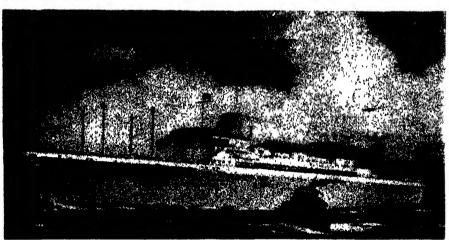
As a result of the fire test findings, all walls, ceilings, floors and other parts of the S.S. Ancon and her sister ships are being built of incombustible materials, so that any shipboard fire, no matter where its origin, can be confined within a limited area.

Additional subdivision of structure safeguards the vessels against damages resulting from collisions or hidden reefs and will make the Ancon and her sister ships practically unsinkable Each ship will be sub-divided into 12 separate compartments, any two of which may be picted simultaneously without affecting the ship's ability to stay affoat. Even if three of these compartments, under some conditions, are opened to the sea, the balance of the subdivisions will keep the ship affoat.

Never before used on any American ship, 'Schat skates' will be fitted to the lifeboats to insure their safe launching even if the vessel is leaning sharply to one side. Instead of being operated by oars, these lifeboats will be propelled by hand levers connected to the propellers, so that pasengers can operate them without difficulty.

The interior decoration of the Ancon is being done by Raymond Loewy, noted industrial designer who is making clever use of numerous fireproof materials, such as stainless steel, aluminum, glass, and plastics. Stainless steel, for example, is to be used on some of the furniture; aluminum is employed for chair frames and stair railings; plastics, compositions, or glass for table tops.

So complete is the attention of experts to safety aboard these ships that, in the words of the committee of experts, "the hazard of fire need no longer be a serious menace to the safety of life at sea."



Artist's drawing of the Ancon as she will appear when completed

THE STUBBORN ELEMENTS

THE story of clement 87 presents a picture of the hard work, successes and failures, repeated promises and disappointments that have gone into the discovery of new elements. It also answers several possible questions that might be raised by the layman who seldom gets closer to such a discovery than reading about it in his newspaper

The first question such a reader may ask is; how does the scatcher even know that such an element ought to exist? To answer this, reference must be made to that familiar old bugbear of students of elementary chemistry, the Periodic Table of the Elements, in which all fundamental relationships are revealed. In that table, the elements are numbered, starting with hydrogen as No. 1 and ending

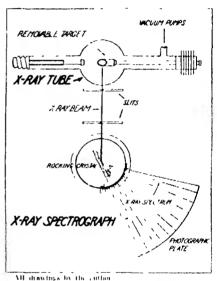


Figure 1. The λ ray spectrograph

with uranium, No 92 Now it turned out, many years after that remarkable classification was made, that the number of any element, that is, its so-called atomic number, also gives the number of outer electrons in the atom of the particular element in question. When the table was first put together, many gaps were found, indicating unknown elements. Many of these were later filled in by various workers.

In the carly days, it was easy enough to identify new elements by chemical means, but as each discovery was made, it left only the more stubborn cases for future workers, so that it became necessary to develop more powerful methods to detect new elements. Thus we arrive at the second question: how has the scientist known when he has a new element before him?

Some Chemical Elements Thrust Themselves Upon Us, Many were Found Chemically, but the Last Few Have Required Delicate Physical Methods of Search

By CHARLES W. SHEPPARD

The most commonly used instrument for making such identifications is the X ray spectrograph (Figure 1) This instrument makes use of the principle of X ray diffraction If a beam of X rays is projected through a crystal, such as calcite or rock-salt, a spectrum can be produced comparable with that formed when light goes through a prism or is reflected from a diffraction grating. This X ray spectrum is not visible to the naked eye. but if it is registered on a photographic plate, certain lines can be recognized Each line on the plate corresponds to a characteristic wavelength of X rays produced by the target of the X ray tube If we use a special X-ray tube with a series of interchangeable targets, these lines are found to be distributed on the photographic plate just as are the lines in a spectrum-that is, in such a way that their wavelengths can be measured. Also, for each target used, the lines fall in different places on the plate, so that each target has its characteristic wavelengths

T was the clever young English physi-I was the ciever young and the cist, Moseley, who discovered that the atomic number for each element was the number of external electrons in the atom With this discovery came a law concern ing the X ray lines of any element in an X-ray target Moseley's law states that the wavelength of these lines is inversely proportional to the square of the atomic number of the element. Therefore, if we know the atomic number of the element we are looking for, we can predict the wavelength of certain lines in its X-ray spectrum quite accurately (Figure 2). If we set up our X-ray spectrograph so as to catch these lines where we expect them to fall, then, if the element is present in the target which we have chosen to use in our X-ray tube, we should know it

This provides one good way to identify difficult elements, but it is well to have another to use as a check. One of the best of these, and one which is almost as sensitive as the X-ray method, is that of positive-ray analysis

Early in the present century, just about the time that satisfactory pumps were discovered for producing a high vacuum, positive rays, or 'canal' rays, were discovered It was found that if an electrical discharge was maintained in a low vacuum, a long, thin tube or "canal' could be led from the discharge to a high vacuum, and that, by sufficiently fast pumping, the high vacuum could be preserved (Figure 3). If this canal were then given a high negative charge, positive particles could be pulled from the are with a high velocity and shot through the canal into the high vacuum. These particles were found to be atoms of the type present in the discharge but minus one or more outer electrons, which accounted for their positive charge. If we put any particular element into the discharge on the low vacuum side of the canal, we can produce positive rays of the element.

Now, a stream of charged particles acts like an electric current. So, if we put a magnetic field across the beam, the beam will be bent. However, the heavier particles are deflected less than the lighter, and if they then strike a fluorescent screen or a photographic plate, there will be a series of spots, one for each particular particle depending upon how heavy it is. This gives us a good way of finding just how much an atom weighs.

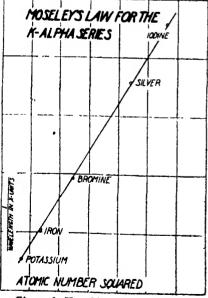


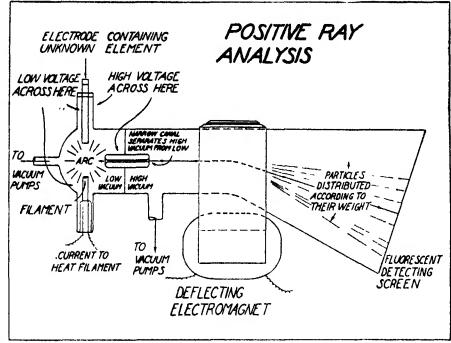
Figure 2: How Moseley's law works

and it has been a most useful device for this purpose. A conclusive way to identify a difficult element, therefore, would be to put it into such an apparatus to see whether we obtain a spot on our plate where we calculate that there ought to be one. Even better than this, if we do get such a spot, we can actually collect small quantities of the element in a pure state by putting some sort of collecting apparatus at this point. If we then examine these minute quantities with the X-ray spectrograph and get the proper Moselev lines, we are definitely sure that we have identified an element.

The next question one might ask is: where do we look for the element? To decide this matter, we obviously should determine its chemical properties. If we examine a Periodic Table, we find 87 in column I together with the alkalı metals, lithium, sodium, potassium, rubidium, and caesium This would suggest to us that our element would behave like its fellows: it would react violently with water to make a caustic hydroxide. For similar reasons, it should have their strong affinity for chlorine, bromine, and iodine. It should be found in minerals rich in caesium. Since it is in the same row with elements like radium, uranium, and thorium, it should be radioactive Two minerals rich in alkali metals are lepidolite and pollucite. In 1929, at Princeton University, Dr. Bainbridge, using the method of positive-ray analysis, looked for the element in these two minerals, but failed to detect it. It was felt that possibly he had not succeeded beforehand in concentrating the element sufficiently in the material to be examined. Prior to this, a number of persons had looked for it but without success

IN 1930, F Albson and E J Murphy, using a magneto-optic method, reported the presence of the element in the above minerals, but it was felt that their work was not sufficiently conclusive. In 1931, at Cornell University, J. Papish and E. Wainer reported finding X-ray lines of element. 87 in the mineral samarskite. These lines turned out to be false.

In 1936, H. Hulubei, in France, reported that he had found weak lines of 1032 and 1043 X-units (one X-unit is 0.0000000001 centimeters wavelength) on a large curved-crystal focusing spectrograph, an instrument very similar to the one described in Scientific American, May, 1932. These lines, he claimed, were the pair of element 87 called the L alpha doublet. However, a controversy arose, for in 1937, F. R. Hirsh, at Cornell University, reported that the lines were off by some six X-units, and it seemed much more likely that these lines were the L beta doublet of mercury which came at 1030 and 1037 X-units. Actually, mercury was known to be present, since it almost always is found in any X-ray tube which is connected to a vacuum pump of the



Liquie 3. Set-up of apparatus for positive ray analysis (see the text)

WHEN a man discovers a ton of gold or a stone in his shoe, he feels positively that he has made a discovery his senses tell him directly. And so it has been with most of the elements. Difficult elements, however, cannot be apprehended directly by our senses but require intermediaries: apparatus. And sometimes the evidence is so tenuous that science remains uncertain. Thus, after all, it is only relative-Iv possible to be sure of discovcry-as is true of all knowledge. —The Eduor.

mercury diffusion type. Hulubei had thought of this but based his claim on the fact that the lines persisted when he substituted oil diffusion vacuum pumps for his mercury ones. Nevertheless, it is felt among most X-ray spectroscopists that, once mercury gets in, it permanently contaminates the X-ray tube.

In this same report, Hirsh described an attempt to find the clusive lines in a concentrate obtained from California Using a target of this material, Hirsh took an eight-hour exposure on the same apparatus as that used by Papish and Wainer, mentioned above. This apparatus had a mechanism for rocking the crystal during the exposure which, besides producing the spectrum, prevents possible flaws in the crystal from producing false lines. This exposure produced a very good line at the center of the plate which had been placed where calculations showed the line would be expected. Hirsh then took a longer exposure, using a material estimated to be concentrated to about nine times the extent of that of the previous sample

The line showed up more strongly. However, although he seemed to be "getting hot," Hirsh felt that there was something peculiar about this line, so, in order to be sure that it was not spurious, he put a blank copper target in the X-ray tube and, to his dismay, found the same line on his plate as before. Undoubtedly it was due to a flaw in the crystal of his spectrograph. The crystal was then set to rock through a larger arc and the line vanished This line was the same one that Papish and Wainer had found on the same apparatus, so it seemed that the field was again open for the discovery of clement 87

It remained open until the fall of 1937, when Huluber reported that he had recorded several additional principal lines of 87. The instrument which he used is the equivalent in sensitivity of many single-crystal spectrographs in one, and if the discovery holds up, it would seem to indicate that previous failures by others were due to lack of sufficient sensitivity.

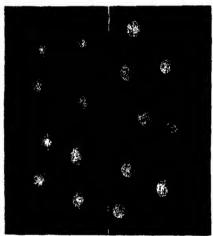
LET us draw some comparisons. Most of us have at some time or other seen a small mountain of scrap iron and known that there is much more than we as individuals could possibly use. Then, in considering rarer elements, we might think of iridium, minute quantities of which are used to tip better grades of fountain pens, and which costs about \$160 an ounce. In an even scarcer class are the elements of the rare earth group. most of which have never been isolated in the pure state. Finally, No. 87 is much scarcer, even, than these. Referring to pure caesium from pollucite, Bainbridge estimated element 87 to be present in amounts less than three parts in every 10,000,000 of this caesium and no doubt it is much scarcer, even, than that

Pearls Through Artifice

POR more than 4000 years, men and women have been fascinated by the beauty of the natural pearl. The possession of these jewels has brought to their owners that esthetic appreciation of elegance, rarity, and authenticity which is the basis of values in all gems and works of art.

It would be strange indeed if during all these centuries no imitations or simulations of this most warmly beautiful of all gems had been developed. The case of the pearl, in fact, has been that of nearly every other rare possession, in that many attempts have been made to reproduce in cheaper form an article resembling as closely as possible the natural jewel

But while imitation is said to be the sincerest form of flattery, the public is



Eight whole cultured pearls, left of line, compared with mother-of-pearl cores from eight cultured pearls of similar size. Cores not small grams

entitled to full knowledge regarding the differences between the authentic article and those made to simulate it. On this premise were developed the stamp of "sterling" on silver and of "24 carat" on gold, to distinguish them from the plated products, and to serve through law and custom as safeguards to the public and the ethical merchant.

It is felt that, up to the present time, the slow processes of law and public education have not yet brought about an adequate recognition of the differences between natural and simulated pearls. In fact, erroneous popular impressions have been reflected in published statements appearing in standard reference works.

In the case of the pearl, two lines of development have been followed in efforts to create through artifice products Man's Two Principal Methods of Simulating Nature's Gem . . . Misconceptions About Biologically Synthesized Pearl . . . New Research Uncovers Facts

By A. E. ALEXANDER, Ph.D. Pearl Fellowship, Mellon Institute, Pittsburgh, Pa

IN attempting to simulate the highly prized natural Oriental pearl, man has resorted to two methods—one entirely mannal fabrication, the other a combination of manufacturing and biological processes. According to the findings of the writer. the Japanese cultured pearl is structurally different and physically less homogeneous than the natural pearl. Contrary to the widely accepted belief, all speomens examined contain a relatively large mother-of-pearl bend or nucleus and not a "tiny irritant"—in nearly all cases comprising 80 to 90 percent of the total diameter of the cultured pearl. The process of culturing pearls is, so to speak, the biological analogue of veneering wood or producing a plated metal.

that simulate the 11ch indescence of the rare and costher natural gem. The first employs chemistry and ceramics to produce an imitation which is, of course, to be considered as a manufactured synthetic article.

The second line of development has involved a combination of a manufacturing operation and a biological phenomenon to produce the so-called "cultured" pearl In this procedure, an oyster is induced by irritation to enrobe a manually inserted mother-of-pearl bead-which in the present commercial article is relatively large in size--with concentric layers of nacreous material. This combination of operations and structures is unique as an industrial technic, an arnele so produced is in part manufactured, and the process is, so to speak, the biological analogue of veneering wood or producing a plated metal.

Methods for producing artificial pearls were recorded over 200 years ago, and doubtless many attempts go back still further Two general types of imitations are manufactured, one employing a solid glass bead and the other a hollow glass sphere. The former are prepared by coat-

ing the glass core with a wide variety of substances, usually a lacquer to which "pearl essence"—essentially guarine, obtained from various species of fish—may be added. The hollow glass spheres are coated internally with "pearl essence" and are weighted by loading with wax and barium sulfate.

In 1935, 15.615 hollow or filled midescent imitation pearls were imported into the United States. In the same year 86, 375,289 inches—the unit in which importations are reported—of solid imitation beads of varying quality, with a total valuation of \$49,803, were brought into the country. Of this number 81.392,590 inches were made in Japan.

A subsequent article will be devoted entirely to natural pearls At this point it should be mentioned, however, that the formation of a pearl in a pearl-bearing oyster is a biological accident. Furthermore, it is interesting to note that by a curious paradox of nature this loveliest of gems is believed to be the result of a pathological condition.

The most ingenious development in pearl artifice has involved bending these natural processes to mass production methods. The original conception on which this industry is based is attributed to the Chinese. As early as the 13th Century, they discovered that, by placing an object—such as a small image of Buddha—in a living mussel and returning the



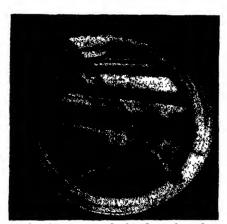
An imitation pearl—a glass bead, lacquered. Note thinness of coating which has been partially removed.

mollusk to its natural environment, a deposit of nacre was slowly built up around this nucleus.

In 1890, in Japan, was begun the present-day commercialization of this Chinese discovery. It is indeed a feat of industrial biology, which may be compared in ingenuity with the accomplishments of the chemists in producing artificial rubies and sapphires. The founder of the industry, Kokichi Mikimoto, after many discouragements, succeeded in producing blister pearls about 1894. A decade or more clapsed before he was able to obtain a spherical form.

The following detailed description of the production of a cultured pearl is taken from Japanese sources:

"The process consists of removing from a living oyster the mantle parenchyma which is used as a bag to envelop the nucleus of the pearl. When this nucleus, which consists of a tiny fragment of fresh water mussel, has been inserted in the fleshy bag, its mouth is secured with a cord, and the whole is introduced into the subcutaneous tissue of the shell-secreting epidermis of another oyster through an opening surgically made for the purpose. In the same operation the cord is withdrawn, the wound made by the lancet is disinfected, and the oyster having been returned to the sca is left to cover the



A thin-sectioned black cultured pearl. Note fineness of laminae and "grain" of large core. This pearl was originally drilled off center

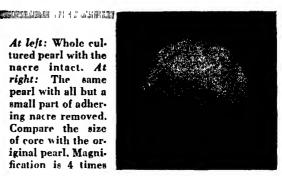
nucleus with the many layers of nacre necessary to produce perfectly spherical pearls."

The concentric rings in the natural pearl and in the outer section of the cultured pearl doubtless are related to some periodicity in the life processes of the oyster. In analogy to annual rings in trees, they might permit an approximate estimate of the period of growth. This information may be known to the Japanese producers, but it has not been published so far as we are aware.

In a thorough examination of a representative collection of several hundred cultured pearls, it has been found that, contrary to the general impression, the cores represent the major part of the



At left: Whole cultured pearl with the nacre intact. At right: The same pearl with all but a small part of adhering nacre removed. Compare the size of core with the original pearl, Magnification is 4 times



article By means of a specially constructed micrometer gage used in conjunction with a binocular microscope, the writer has observed that, with few exceptions, the linear diameter of the core is 80 to 90 percent of the whole diameter. The outer shell of nacre is, therefore, comparatively thin. The widely accepted popular belief that the nucleus of the biologically synthesized pearl is a "tiny irritant," apparently rests on such statements as: "this nucleus, which consists of a tiny fragment of fresh water mussel, etc.

The nucleus consists of mother-ofpearl substance-ordinary calcium carbonate with an adhesive protein constituent-which has been manufactured from mollusk shells. This core or bead is shaped into a sphere by mechanical means and is then given a high polish

MONG procedures used in this inves-A tigation as well as by other scientific workers for the study of pearl material, are the usual chemical and physical tests and X-ray radiographic technic. The petrographic microscope has revealed particularly interesting information in the writer's research by permitting more searching examination of the structure of exceedingly thin sections. In the natural pearl the nacreous material has been deposited in very fine concentric layers throughout the jewel. In the cultured pearl the comparatively large core, as would be expected from its origin, is found to be built up in distinct parallel layers. The outer shell of nacreous ma terial is seen to consist of concentric layers. The mineral matter is aragonite, the orthorhombic form of calcium carbonate, although in a few cases calcite has been encountered.

Because of the external characteristics of the shell of pearl matter, the layman may feel that the cultured pearl and the natural gem appear to be the same. By expert visual examination, however, and particularly by the use of special physical apparatus, the two can be differentiated. As in the case of other objects of esthetic value, it is necessary for the uninitiated to rely upon the knowledge of the expert, who by training and experience is qualified to reach authoritative conclusions on such matters.

The Japanese cultured pearl, with its margaritic substance around a motherof pearl bead, does not possess to a similar degree the mechanical homogeneity of the natural pearl. A knife edge applied to the surface, when struck with a light mallet, usually causes the outer shell to break off in whole or in part. Natural pearls show a different type of spalling. permitting the conclusion that the concentric structure does not have a zone of separation or weakness.

As an additional procedure for the examination of drilled cultured pearls, it was found that when a dye solution, such as methylene blue, is inserted into the bore by means of a fine needle, the color spreads at once throughout the zone of separation between the inner core and the outer nacre. The phenomenon is readily followed by the use of a microscope. When this test is applied to natural pearls, no penetration of dye takes place. It has been reported that this property of cultured pearls has been taken advantage of, to an extent that is not known, by dyeing them to improve color and appearance and to simulate the inherent characteristics of such special types of natural pearls as the black variety. We have observed specimens which give evidence of having been subjected to such treatment.

Accurate figures on the number of cultured pearls produced and marketed are not available. For several years prior to 1931 it is reported that an average of about 3,000,000 oysters were set annually, and in 1931 this number was increased to more than 6,000.000. Of the total number of oysters set, it is said that only 60 percent will produce cultured pearls of salable value.

The cultured pearl industry in Japan is "big business" and for that reason it is casy to believe that the number now being produced in Japanese waters exceeds by millions the quantity said to have been obtained in 1931. Labor in Japan has been both cheap and plentiful, especially so since women are well suited for this type of work.

The situation is further complicated by the fact that the business of reproducing cultured pearls is no longer confined to Japanese waters. Advertisements mention the South Sca Islands and an examination of some specimens reveals characteristics not found in Japanese cultured pearls. The extent of the industry outside of Japan is not known.

OTHER DAYS IN PHOTOGRAPHY

IN 1839, just a century ago, Daguerre announced his discovery that an image could be formed by light acting on an iodized silver plate. Then followed the tremendous popularity of the Daguerreotype, first successful forerunner of our present-day photographs. Through the Callotype and the wet-plate process, the collodion and the gelatin emulsions, progress was steady but slow Only with the advent of flexible film did photography receive the impetus that has made possible the highly efficient cameras, films, and printing papers which we have today. The accompanying illustrations show some of the difficulties under which photographers labored during the 19th Century



Right: A roof-top photographic studio of the 19th Century. Strong sunlight was necessary for picture taking, and the ex-

posures stretched to seeming eternity—for the subjects. To keep the sitter from moving during these long exposures, an "immobilizer" was used

Left In the days of the wetplate process, the photographer had to coat his own plates in the darkroom. First he cleaned the glass thoroughly, then coated it with collodion and sensitized the surface. Plates had to be exposed immediately, before the collodion had time to dry out







An amateur photographer of the 1860's starts out to take a few pictures. He had to carry, in addition to his camera, dark-room and wet-plate-making equipment!

"On location," the darkroom tent is set up, a plate is coated, and an exposure is made at once. The photographer's assistant is ready with a newly sensitized plate

THE HYSTEROID PERSONALITY

While the Paranoid Type Aggressively Hews to the Line and Faces Facts, the Hysteroid Personality Seeks to Evade Difficulties by Sidestepping Reality

By PAUL POPENOE, Sc.D.

Director, The Institute of Family Relations, Los Angeles, Lecturer in Biology, University of Southern California

WHEN an animal faces danger, it may react typically in one or the other of two contrasted ways: it may advance and attack; or it may retreat, run away, and hide. These primitive biological reaction-types color human behavior just as they do that of a tiger, a shark, or a scorpion. Greatly extended and variegated, they result in two contrasting types of human personality.

The paranoid follows the attack-pattern. The man (or woman) with a typical paranoid personality is always on the aggressive. He is not merely ready to meet trouble when it comes: he is looking for it, and is prone to imagine it where it does not really exist. His whole life tends to become a fight.

The hysteroid follows the other pattern. The man (or woman) with a typical hysteroid personality is always on the defensive, always trying to escape, not merely from real but likewise from imaginary dangers. His whole life tends to become an evasion, a sham, a pose.

There is a difference in the complexity, in the diversification, of the two types of personality, which reflects the differences in nature.

In general, there is only one way to attack an enemy: you simply attack him You go after him tooth and nail Corresponding to this, the paranoid pattern sometimes seems therefore to be fairly simple. By contrast, there are a lot of ways of escaping from an enemy. The animal may simply flee, depending on speed, as does the antelope, or it may. instead, dig a hole in the ground and crawl into it, as does the badger. It may pretend to be injured, as does the quail suddenly startled from her nest. It may pretend to be wholly dead, as do many insects and other animals, proverbially the opossum. It may change its color to become inconspicuous, as does the chamelcon. It may throw out a cloud of ink to color the water and hide itself, as does the cuttle-fish. It may make itself offensive, as does the skunk. It may mimic an

1See "The Paranoid Personality," by the same author. Belefitific American, February, 1938, pages 74-77,--Ed.

offensive species, as some insects do, so that enemies, confused, will avoid them It may, though harmless, look so hideous and formidable as to scare away marauders.

One could find types of human behavior corresponding, figuratively, to all these and many other animal patterns As methods of escaping trouble, they may properly be brought into the general picture of the hysteroid personality

Historically, the term hysteria has a



Among famous persons, Tolstoy has been mentioned as a hysteroid type

more limited use, applied particularly to physical conditions. Hippocrates, the Greek "Father of Medicine," described various vague and fluctuating symptoms in women, which he explained by supposing that the womb (hystera) wandered around in the body seeking humidity and, by transient pressure on various structures, caused transient symptoms of discusse.

Modern biologists naturally take a less naive view of the physical basis of hysteria. They would relate it to two of the most primitive and deep-seated nervous mechanisms of the individual.

One of these is the tendency of an animal to make violent and spasmodic move-

ments when trapped or frightened. Thus a bird, flying steadily enough, finds itself suddenly inside a porch. It beats violently against the windows and walls until it accidentally finds a way of escape, whereupon it once again begins to fly as evenly as before. The other mechanism is the sham-death-reflex as seen in the opossum.

In the case of a great shock or panic, such as might accompany an earthquake or holocaust, many persons are said to become "hysterical." They rush around wildly and apparently without reason, as does the bird trapped in a room. On the other hand, many fall into a sort of stuporous state (like the opossum) in which their behavior is irrational but actually, no doubt, serves the purpose of protecting the nervous system from further shocks that it could not withstand. Plenty of illustrations of both types of behavior were seen in soldiers during the World War.

ACTING through such fundamental mechanisms in the organism, the strong primal urges of self-preservation (fear, as in war) and species-preservation (sex) produce "hysteria." The process is, diagrammatically, something like this: (1) desire to escape from danger, (2) suggestion of a way of escape, (3) accidental escape through the way suggested (that is, some "symptom"), (4) fear of return to danger with recovery from symptom, (5) exaggeration of symptom, (6) fixation of symptom through the usual methods of habit-formation, (7) final existence of the symptom without any cause.

To make the picture more concrete, take such a case as occurred over and over again during the war. N. was knocked down by the concussion of an exploding shell Of course he was bound to be somewhat injured. His aim was bruised. He was taken to the hospital and bandaged

His whole being revolted against going back into danger. It was easy for him to "discover" that the arm was more seriously injured than the doctors thought. It did not get well—it became paralyzed. He had to be sent away from the combatant sector because his arm, now paralyzed, made him useless there.

His arm really is paralyzed now: but it is a functional paralysis, a hysterical paralysis. He is not malingering—that is, not consciously pretending. The whole process is unconscious but none the less real. He is sent to a convalescent camp His arm shows no improvement: the war

is still on. Then the announcement of the armistice is broadcast. He no longer need fear going back to the trenches. He no longer needs a paralyzed arm. Hence his arm begins to get well. The mere announcement that there would be no more fighting cured, sometimes almost miraculously, hundreds of soldiers with these hysterical disabilities ("shell-shock").

Such a case represents, in simplified diagram, the "classical" form of hysteria—the simulation of a disease as a protection against danger.

Anyone is theoretically capable of hysteria, because all have these fundamental biological mechanisms; but some are much more easily affected than others Women are more susceptible than men, as Hippocrates recognized when he ignorantly picked out the womb as the source of trouble. The main psychological difference between the sexes, as reported by Terman and Miles in the most comprehensive study yet made ("Sex and Personality," 1937) is the greater aggressiveness of the male. Hence the paranoid personality is more likely to be found in men. Women will be more ready to escape than to advance and attack, hence the hysteroid tendency is more often distinguished in them. But since any woman can fight and under certain circumstances will do so; and since any man can and may run away, the possibilities of both types of behavior are present in both sexes.

Though contrasted, the two types are not mutually exclusive: all of us have some tendencies in each direction. It is only in pronounced cases, where the balance is greatly on one side, that we speak of the paranoid personality or the hysteroid personality. Most of us are betwixt and between

THE pronounced hysteroid personality represents a special make up that apparently depends to a considerable degree upon heredity. The following components tend to be present in varying amounts:

- 1) A tendency to easy dissociation of the nervous system. This is characteristic of the extravert, not the introvert, and pronounced hystericals are likely to be of the extravert type. One part of the consciousness can be "split off" from the rest, as when a person is hypnotized. This makes possible the striking physical manifestations such as the genuinely paralyzed arm of a soldier who is organically sound. Hysteria may simulate almost any disability in this way.
- 2) An imperfect development of the organism, a physical infantilism. This is often seen most clearly in the reproductive system, but presumably may characterize the whole organism.
- 3.) An emotional infantilism Though adult by the calendar, the individual has retained the infant's characteristic egocentricity, selfishness, suggestibility, lack

of self-control, vivid imagination, and immaturity of impulse. "Who, in the examination of a hysteric, has not hundreds of times cried out that he had a big child before him!" observed Pierre Janet, the French neurologist who gave the modern concept of hysteria much of its form. Really superior persons are rarely found to show symptoms of hysteria (a term now generally reserved for physical manifestations such as the paralyzed arm). They may have the hysteroid personality in some degree; but those who have it so markedly as to show striking results of dissociation are likely to be personalities that are undeveloped and poorly put together anyway. The history of witchcraft and of miraculous "faith cures" will yield any number of illustrations.

While the biologically defective personality marked by the three traits I have just named is most likely to make conspicuous-indeed startling-use of the escape mechanisms underlying a hysterold personality, all of us have some tendency in that direction, as I have previously emphasized. The traditional "Sunday morning headache" which makes one feel that going to church would be harmful and that a game of golf or a trip to the beach would be more desirable-in fact necessary to well-being-is merely one of the everyday forms of hysteroid mechanism. Who of us will declare that he has never taken refuge in such an evasion?

Remembering that the purpose of hysteroid behavior is to escape from unpleasant, unwished-for, or dangerous situations, one can see how simulated illness can be used in a variety of effective ways:

- I) To escape from threat to one's life, as in the war-time hysterias of the "shell-shock" type.
- 2) To escape from some other situation that is feared as dangerous Miss Q is afraid of sex, fears marriage, and therefore becomes a chronic invalid as a means of self-protection. Her relatives won't insist on her marriage, in that case
- 3) To escape honorably from responsibility. An important function of the hysteroid mechanism is to enable one to keep his own self-esteem, to "save his face," to think well of himself, at the same time that he runs away. Many a woman, faced by an invitation which she wants to decline, finds herself too unwell to attend. As is often the case with the hysteroid personality, conscious and unconscious deception blend into each other so closely that no one can draw a line between them. One of the characteristics of the hysteroid personality is its great capacity for self deception The woman who does not want a visit from her mother in-law may take to her bed with a spell of indigestion just as real, in its way, as the soldier's visibly paralyzed arm.
- 4.) To escape from neglect, that is, to get attention A large part of the every-

day hysterical manifestations are of this type. The hysteroid, being essentially a spoiled child, with all the spoiled child's selfishness, conceit, desire to show off, and indifference to the interests of others, is continually getting attention by being unwell, being delicate, needing special care. Mrs. C., like ten thousand other dissatisfied wives, governs her hushand and dominates the whole family in this way She must not be "crossed" because it will affect her so unpleasantly. She must always be humored, catered to, toadied to, because she deserves so much sympathy. Her life is such a burden to her that the least we can do for her is to try to give her a little pleasure. And how she does "enjoy ill health!"

5) To escape creditably from the consequences of some personal deficiency. Mr. L. 15 a tennis player-not a very good one but with enormous self-esteem Like typical hysteroids, he plays only to win He is not too scrupulous in his code of sportsmanship. If he loses, there is always a good reason. "I knew I wouldn't win today I was miserably sick all night", or 'I didn't try this afternoon, my head was aching so hadly that all I could do was wonder whether I could get through the last set without collapsing on the court." In such circumstances, you are supposed not to depreciate his ability but rather to admire his fortitude, to praise the plucky fight he put up against what he knew to be overwhelming odds! When he once reached the semi-finals and faced an opponent sure to defeat him, he "had to" default through illness, he went to the hospital with one of his spells and sent a pathetic telegram regretting the loss of the cup when he felt that it was right in his bands.

EAVING now the classical form of genuine hysteria, it is important to follow the hysteroid personality out into its borderlands where it is manifested by mental rather than by physical symptoms. One will encounter, in such an excursion, a wide range of escape mechanisms such as have already been described among the lower animals.

Thus a man may escape danger and save his face, not by "flight into illness" but by flight into obscurity. As the cuttle-fish conceals itself by a cloud of ink, so a man may conceal himself by a cloud of rhetoric and mysticism. Followers of various superstitions (astrology, spiritualism, some of the "New Thought" cults) surround themselves with a mumbo-jumbo of big words and meaningless ideas which make them feel very superior and protect them from having to compete in everyday life. This, like the form of escape preceding, shades off imperceptibly into an inferiority complex of the ordinary, uncomplicated type.

The underworld of the arts is inhabited largely by hysteroids. Faddist cults which

claim exemption from all the rules of physical and natural science form an excellent example of hysterical mimicry -the attempt to gain prestige by sham and wishful thinking. The hobohemians and Greenwich Villagers (using that term in a spiritual rather than a geographical sense) who take up post-ultrasuper-modernism in art have in many instances found an exceedingly effective way of escaping from the danger of having to earn a living, of having to succeed by open competition in the world. Would-be actors and actresses likewise live on pose rather than on performance, in many instances. Anyone acquainted with this lunatic fringe of fakers and posers around the world of art cannot help being impressed by the infantile and disorganized personalities that comprise it.

The French novelist Stendahl (Henri Beyle) is a good illustration at a somewhat higher level. He loved falsehood and dissimulation just as a matter of "art for ait's sake." He changed his name; he filled his books and letters with deliberate and useless falsifications of dates and places, he could not even R.I.P. under the truth but had a false hood engraved on his tombstone

If we emphasize the trait of abnormal susceptibility to the determination of one's ideas by one's own wishes, we can follow the hysteroid personality into another wide field of human activity where Don Quixote has been named as the perfect literary illustration—always investing his surroundings with the forms that he wanted to see in them. It has been remarked that most of Ibsen's heroes and heroines (notably Peer Gynt) are typical hysteroids.

Turning from fiction to history, Napoleon I is worth noting as a typical paranoid who also had strong hysteroid tendencies that became more pronounced in his later years. During the Russian campaign, he was continually making himself believe that his forces were much greater than they really were, that the enemy was weaker than it really was; and his staff were often at their wits' end to combat this infantile behavior and to make him face the facts. His callous egotism and ruthless dishonesty are also typically hysteroid. When a man of first-class ability has pronounced paranoid and hysteroid tendencies at the same time, he is likely to be a first-class menace to his fellow men!

Politicians tend to fall into two separable groups. One is made up of the paranoids—aggressive, dominecting, driving ahead ruthlessly, crushing opposition relentlessly; stubborn, suspicious, helligerent—a type illustrated by some political bosses in America and by such well-known figures as Georges Clemenceau and Thaddeus Stevens. The other is made up of the hysteroid type—posers, gifted

with imagination and continually dramatizing themselves before the public. "Their natural bearing is pose," says O. Bumke, the German psychiatrist, of hysteroids in general.

Not to name any living worthies, probably at least a touch of this hysteroid element could be seen in men eminent in such diverse ways as Disraeli and Talleyrand, Alcibiades, and Thomas Jefferson; much more than a touch of it in the late Huey P Long. When one passes to the small fry, the hysteroid tendencies are often paramount, and not always the



Wagner, the composer, is thought by some to have been a hysteroid type

pleasant hysteroid components, either—too often the unpleasant ones such as sham, dishonesty, double dealing, callous disregard for the rights of others, readiness to repudiate legitimate obligations—anything to get ahead

ALL this is just the opposite of the typical paranoid's behavior. Stubborn and persistent, he is the man to stand up for a principle, right or wrong; to die in the last ditch rather than abandon the "cause." The natural history of politicians deserves particular consideration because it furnishes excellent material to differentiate the behavior of paranoids on one side and hysteroids on the other

Needless to say, the hysteroid personality is a prolific breeding-ground for criminal behavior. It will be found more rarely among those convicted of crimes of passion. It is almost universal among those convicted for crimes of gain—the white-livered crook who is trying to "beat the game" and get something for nothing; the double-crossing racketeer who is convinced that "only saps work." Indeed, the best known scale for measuring the hysteroid component of the personality was standardized by being given to convicts in a state prison!

This type of hysteroid blossoms most exuberantly among the "big shot" frauds and swindlers, the bluffers and confidence men who get even more satis faction from strutting across the stage and "putting one over" on the public, than from their actual gains. Joseph Balsamo, who called himself Count Cagliostro, is one of the outstanding historical examples; John Law of the Mississippi Bubble another; Horatio Bottomley, once a member of the British Parliament, a third. For American examples, one has merely to look into the daily newspaper. The big business world contains too many; the business underworld is largely made up of them.

There is a hysteroid sort of "philanthropist" who represents—whether male or female—the worst traits of the "Lady Bountiful" type, an ostentatious and hypocritical humbug, dishonest in private dealings but loud in his pious protestations on the public platform. There is at the other extreme a hysteroid type of pauper—the whining beggar, apt at evasion of all responsibility, preying on society, living by deceit and occasional erime, satisfied with himself and completely lacking in sympathy for others.

IN short, the hysteroid personality can be found in every walk of life. When combined with strong impulses to selfassertion, and associated with inborn talent, the hysteroid's dramatic flair and his ability to make his wishes seem real to himself may lead to great achievement, most frequently in the field of art, religion, or politics. Among eminent men who have been named by one writer or another as hysteroids are Berlioz, Blucher, Flaubert, Frederick the Great, Goethe, Moliere, Muhammad, Nietzsche, Pascal, Rousseau, Schopenhauer, Strindberg, Tolstoy, and Wagner. The reader's own predilections will color his judgment but everyone will agree that at least some of those named belong among the hysteroids.

If the extreme hysteroid has a different type of constitution from the average person, it is evident that both prevention and cure will be difficult.

"Spoiled child" tendencies appear early and are largely fixed during adolescence. An education that prevents the development of a "spoiled child" will prevent the development of a hysteroid. Most is to be hoped, therefore, from a better technique of child guidance.

In dealing with an adult, one tries to make him see why he is sick, but also to give him a desire to be well. If the cause can be removed—if the patient can be made to face his situation honestly, and can be re-educated to make a superior sort of adjustment—his whole career will be changed.

But it would be optimistic to think that much can be done with an inferior, infantile, disintegrated adult who is making use, to his own great satisfaction, of such primitive biological mechanisms as are the basis of the hysteroid personality.



A MONTHLY DIGEST

PROSPECTORS NOW DIVE FOR GOLD

AN ingenious method of prospecting for gold and silver has recently come to light. Rather than drill into the ground by conventional methods, certain prospectors are now diving to the bottom of lakes in

Ready to dive-for gold!

Canada in their search for rich gold veins and silver ore deposits.

Largely responsible for making possible this under water prospecting, is a device known as the McCaa Two-Hour Oxygen-Breathing Apparatus, a product of the Mine Safety Appliances Company Strapped on the back like a pack and weighing approximately 30 pounds, the equipment consists of an oxygen container, a face mask, and tubes to convey the oxygen to the mouth of the diver it functions without a pump, the oxygen being fed to the diver's lungs by means of an automatic lung in the equipment. This equipment, good for a two-hour immersion in shallow water, may be used in 40 feet of water for periods of one hour

Accepted among geologists is the fact that

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN
In charge, Daniel Guggenheim School
of Aeronautics, New York University

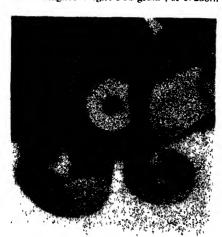
D H KILLEFFER Chemical Engineer

most of the mines found to date are close to bodies of water, and that the best ore seems to occur under lakes. It is on this theory that the under-water prospector bases his efforts and hopes. The diving prospector, after donning the apparatus, takes with him a water-proof flashlight and a geologist's hammer. The practice followed is to have one man remain on shore, the diver carrying a line and making signals according to a prearranged code. The equipment carried is heavy enough to hold the diver down, yet not too heavy to permit him to move with ease with a swimming motion.

MOST POWERFUL PERMANENT MAGNET

THE most powerful permanent magnet in the world—one that will lift nearly 1500 times its own weight—has been developed in the Research Laboratory of the General Electric Company by W. E. McKibben

The magnet weighs 1 85 grams, or 1/250th



The powerful magnet (between finger and thumb) and its steel casing



1500 times its own weight

of a pound, and has been made to lift 2750 grams in tests. About half the size of an craser on the end of a pencil, it will lift a five-pound flatiron with case. The new magnet is several times as strong as those previously made.

The magnet is made of a material known as Alnico, an alloy of aluminum, nickel, cobalt, and iron. This alloy was first developed as a heat-resisting alloy which resisted scaling and deterioration at high temperatures. Research on the magnetic properties of alloys of this type was later carried on by Professor T. Mishima of the Imperial University, Tokyo, and General Electric perfected a process of heat treating by which the magnetic properties were more fully developed.

The new magnet employs the same alloy as previously used, but utilizes a steel sheath around the Alnico pellet to direct the magnetic flux against the keeper or object being attracted. The steel jacket also protects the magnet against demagnetization when not in use.

EXPLODING WALNUTS

A NEW method of shelling walnuts, recently developed at the University of California, uses an explosion to burst the shells. The shelling operation, which is done by machine, consists of passing the walnuts over a circular saw which cuts an opening through the shell; blowing explosive gasair mixture into the nut; and finally passing the nut through a flame which explodes its gaseous content. This method of breaking shells avoids fracturing the nut meats, which are not affected by the explosive. The machine in which this series of operations is accomplished opens about 900 pounds of walnuts per hour.—D. H. K.

ANTHRACITE

NEARLY 1,000,000 railway cars are required each year to transport anthracite coal, producing railway revenue of about \$100,000,000. All the railway cars required in a year would make a train more than 8000 miles long—more than enough to reach across the United States and back

Invention Helps Drainage Ditch Work

IMPROVED equipment for cleaning ditches is one of the by-products of large-scale work by CCC camps to put public drainage ditches in better condition. One new machine that promises good results was described by D. A. Isler of the U.S. Bureau of Agricultural Engineering before a meeting of the American Society of Agricultural Engineers. The machine consists of two winch drums on a truck chassis that has a light boom extending from one side for operating a scraper. It is used where dragline excavators cannot be used economically.

As Mr Isler described the use of the machine, dirt loosened in the ditch by plowing is removed with scrapers pulled by a cable from one of the winch drums. Another cable running over the boom from the other winch returns the scraper to the middle of the ditch for reloading. He said three such machines have been built by the bureau and are now in use at CCC drainage camps.

The machine can be easily mounted on and removed from practically any make of truck of 1½ tons or larger. The apparatus is mounted crosswise of the truck bed. Rigid blocking is provided between the rear axle

1 1 1 1 1 1 1 1 1



Grand-daddy of the aluminum license plates for automobiles, now being used in Connecticut and Arkansas, is this aluminum tag for horse-drawn hacks issued by Pittsburgh in 1898. It was of such shape as to be fastened around one of the shafts of the carriage, with the tongue of the plate through the slot on other end

and the truck frame to eliminate spring action and stabilize the truck while at work. The blocking can be removed for traveling on highways. The cost of the attachment, not including the truck, is estimated at \$1000. The outfit will handle 10 to 15 cubic yards an hour at a cost of 25 to 35 cents a yard It is operated by a five-man crew.

MAN WILL WIN WAR WITH INSECTS

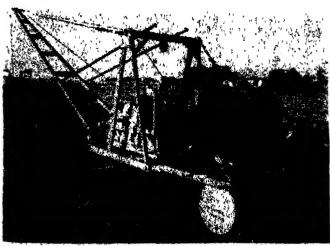
W AR between man and the insects, usually pictured as fraught with due disaster to the human race, is going to end in victory for mankind, prophesied Professor J. J. Davis of Purdue University, in his address as president of the American Association of Economic Entomologists (See also "Insects Cannot Win" on page 222 of this issue.)

"When we realize that the science of applied entomology is scarcely more than 60 or 70 years old and note the progress in insect

control during that time," said Professor Davis, "we realize at once that man is gaining the upper hand. We may anticipate the time when our chemical, electrical, and mechanical warfare, insect-resistant varieties of plants and breeds of animals, and our farm and home practices, together with the aid of insect natural enemies, will reduce insect control to a routine, just as the medical profession has reduced or practically eliminated disease fatalities which were once responsible for the loss of thousands of human lives."

Victory will not come automatically, though, Professor Davis warned. Not merely eternal vigilance, but eternal research, is its price, for the front is always changing, as new crops are menaced by new pests, or as new business or social practices change people's relations to insects.

Professor Davis expressed the feeling that while it is now comparatively easy to get funds for insect control by known means, and to meet situations as they now exist, not nearly enough support is given to the research programs and the training of new





The new disch-cleaning equipment used by the CCC, left, and, at right, scraping a ditch



The control car of the K-2 is built into the hull. Note the airscoop in the slip-stream of the propeller. Below. The K-2, largest non-rigid airship, landing

research workers, to meet new problems that will arise in the future. He pointed out, as an example of a problem of the rather immediate future, the necessity for knowing much more about insect infestations in stored grain, in connection with the evernormal granary project of the U.S. Department of Agriculture—Copyright by Science Service

HEAT VS. HUMIDITY

COMMON report has it that discomfort in the summer time is due not to heat but to humidity. However, in air conditioning for comfort, most systems so far in use are based on cooling rather than simple dehumidifying A new system, called "Caloride," actually does something about humidity and operates on the principle of reducing humidity to a comfort point without materially changing the temperature of the air. A special form of briquettes of calcium chloride are used to absorb moisture from air passed over them. The system uses ordinary city water as the only cooling medium and has no refrigerating machinery and D. H. K.

LARGEST NON-RIGID

WHILE the very large rigid airship is temporarily under a cloud, the much smaller non-rigids (commonly known as "blimps") are being built by Goodyear for both the Army and the Navy Such airships did perform many tasks during the World War which no other aircraft could undertake, particularly in locating submarines, in patrolling the North Sea, in destroying enemy mines, and so on.

There is every reason to believe that, no matter what advances may have been made in heavier-than-air machines, the blimps will still serve a useful purpose in what we must unfortunately call the next war. This is all the more likely as the blimps have themselves advanced considerably over the crude form which they exhibited during the World War. Thus with the use of helium, and with certain structural refinements, it is found possible to eliminate the cable sus-

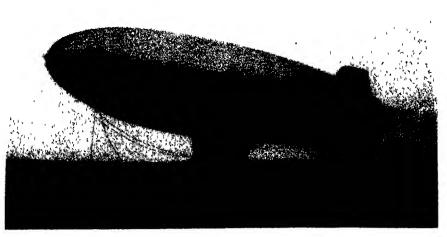
making tests in its full-scale wind tunnel, to determine the drag of a typical liquid-cooled engine. These tests show that the engine nacelles of a four-engined model increase the drag of the whole airplane about 8 percent and the cooling (Prestone and oil radiators) system adds another 15 percent. As a result of these and other studies, it would expear that liquid couled engines.

shaft. Meanwhile, the N.A.C.A. has been

As a result of these and other studies, it would appear that liquid-cooled engines should be placed within the wing; the radiator should also be enclosed within the wing, with air led in through ducts from the outside. With the radiators placed at the largest cross-section of the duct, the drag increase is only 2 to 3 percent, as compared with the 15 percent of the conventional ar rangement mentioned above A. K

AIR POWER IN NATIONAL DEFENSE

SPFAKING of "Modern Air Power" at the annual meeting of the National Acro nautic Association, Major-General Frank



pension of early days and the modern control cabin is built into the lower part of the hull. It provides comfortable quarters for a crew of seven—pilot. radio operator, navigator, mechanics. The old stove-pipe blowers have been replaced by neat airscoops placed in the slipstream of the propellers. The landing gear has become retractable.

With these various refinements the U. S. Navy K-2, largest non-rigid airship ever built (with 404,000 cubic feet of gas volume), has a speed of close to 80 miles per hour, a gross lift of 25,000 pounds, and a ratio of useful lift to gross lift which is so high that the new airship can cruise non-stop for several days. The two 550-horsepower Pratt & Whitney engines mounted in the outboard nacelles each turn three-bladed propellers 10 feet 6 inches in diameter.—A K.

Enclosing the Aircraft . Engine

NE of the most obvious possibilities for improvement in aerodynamic efficiency lies in the reduction of the drag of the engine and cooling system. Licutenant McCoy, reading a paper before the Institute of Aeronautical Sciences, strongly recommends that liquid-cooled engines should be enclosed within the wing, and that propellers should be driven through an extension of the motor

M. Andrews, Commanding General, CHQ Air Force, made it perfectly clear that the airplane has changed all conditions of warfare.

"Modern air power in future wars makes the picture different," said General Andrews "The ability of air forces to operate in three dimensions enables them to move over land and water without regard to obstacles on the earth's surface. Their freedom to select the time and place of attack, to operate during day or night and to use the clouds for concealment, makes adequate defense against air attack on a grand scale a serious problem Air forces, unlike ground forces, are not forced to wage an exhausting war at a nation's frontiers. The speed at which airplanes travel enables them to cover long distances in a short time. It is these characteristics of air forces that increase the power of the offense in war and make the airplane such a terrible instrument in the hands of un scrupulous governments.'

Discussing the range of the bomber in the same address, General Andrews points out that our ocean bulwarks are shrinking and that only a short time ago two British bombers flew non-stop from Egypt to Australia, a distance of 7160 miles. "I believe that any of our large airplane companies would be glad to contract to build a bomber capable of a tactical range of 10,000 miles. If American airplane manufacturers can build such

a homber, it can be done in other countries."

The well-informed views of General Andrews, news from Spain, news from China, the Münich accord, all make it perfectly clear that we must put forth a real effort to retain air power. In the production and number of service airplanes we lag behind seriously, and the Administration program of building planes in large numbers comes none too soon.

But while acknowledging our lag in the production of airplanes, we have been accustomed to comfort ourselves with the reflection that if we do not lead in numbers we lead in aeronautical research and in the performance and fighting qualities of such air craft as we do have. Now the situation is changed regarding research. Thus, T. P. Wright, making his address as retiring president of the Institute of Acronautical Sciences, gives a pessimistic view of our position in aircraft experimentation and development: "A few years ago the United States was well in the lead in research, development, and production of aircraft, a fact attested by all who had the opportunity of visiting European countries at that time and of witnessing the scope of developments there I title could be learned from abroad at that time by Americans, Recently, how ever, visitors abroad have witnessed a great change. Many huge aeronautical laboratories have been established and are occupied in intensive research investigations. It is definitely established that the relative position of this country is reveised from 1931.

Brigadier-General W. G. Kilner, Assistant Chief of An Corps, also speaking before the National Aeronautic Association, took a similar point of view. Our supremacy in prototypes has disappeared, and we are falling behind in research and fundamental developments. Last year Great Britain spent fifteen million dollars on research in military aeronautics, France more than ten milion. No one knows what Germany and Italy spent for the same purpose. We spent only six million dollars.—4. K

INACCURATE AIRPLANE BOMBING

IN our October 1938 issue Major Arthur E Oxley discussed at length the question of the military value of airplane bombing, and pointed out that airplanes nowadays are forced to fly at such high altitudes that it is very difficult for them to hit important targets of military value.

Recent summarizing of the effects of the bombing of Barcelona in the Spanish Civil War bears out this conclusion. The records show that during the six days from December 5 to December 10, 1938, a total of 455 bombs were dropped by insurgent airplanes on Barcelona with the result that two people were killed and ten injured, while two horses were killed and one motor truck damaged. Obviously the only real effect must have been on property, for the residents of Barcelona had long since passed the point where air bombing did anything in particular to their morale.

The record further shows that during the course of the War this city was subjected to a total of 2000 air raids. Despite this extremely large number of raids, in which many thousands of bombs poured from the skies, no military objective was damaged greatly. The principal targets—the gas works and the central electric station—suffered only minor damages.

In view of these facts civilian populations everywhere will be reassured, though there is no question that much work has yet to be done in the matter of providing underground shelters such as were built in Barcelona.

Airplanes to Fight Forest Fires

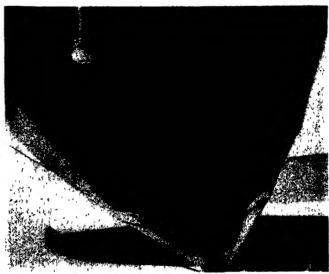
THE U. S. Forest Service has recently purchased a Stinson Reliant freighter model airplane, equipped with a 450 horse-power Wasp engine, for interesting experiments in fighting forest fires from the air.

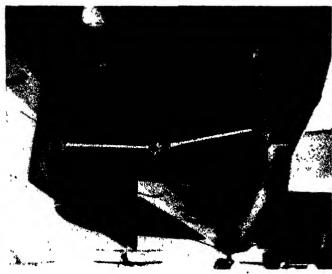
Instrumentation on the ship is exceptionally complete to permit precision flying. In the hottom of the fuselage a special floor is incorporated (as shown in our photographs) with trap doors and a hatch opening 22 inches by 40 inches. Through this opening containers of water or fire-fighting chemicals can be released as desired. For cargo dropping work, guide boards are placed above the hatch opening. In addition to the hatch assembly and release gear, the ship is equipped with a new bomb-sight which gives a high degree of accuracy at low elevation. Military bomb-sights are in-tended primarily for high-altitude work and, aside from the factor of cost, are somewhat too complex for use in civil aircraft.

Before this new equipment can be put into practical service, a great deal of research will be necessary. The trajectory in space of mexpensive commercial containers must be studied. The bomb sight and release



Specially designed plane built for the U. S. Forest Service for fighting forest fires. Below: Views of the trap in the fuselage, shown open and closed







How the engine cowl of the interceptor fighter described below may be opened for convenient servicing of engine. Right, CW 21 in flight

equipment must be perfected. Then a new technique must be developed by which plots and "fire hombers" will be able to protect our forests. Another incidental study is that of dropping supplies, with the aid of sample parachutes, to fire crews or others cut off from usual methods of transportation.

This basic research is of great importance and value, and we wish the Service every success in its efforts —4 K

A GREAT INTERCEPTOR

THE Carries Wight (# 21 Interropted Fighter to a magnifect in admire, sphendedly first for it meny aircraft, An autrophysical for the comparation of the comparation

It is emitins to see what a unitary are plane of this type has to carry the weight empty is 3050 pounds, and the neeful load of 1200 pounds is divided in as follows fuel, 876 pounds, oil, 61 pounds, ordinance, 190 pounds, 1904 and patachine, 190 pounds, 1905 and 1905 and 1905 and 1905 pounds, 1905 and 1905 and 1905 and 1905 pounds, 1905 and 1905 and 1905 pounds, 1905 pounds, 1905 which is trowded unto a relatively small machine with a span of only 35 feet

One of our photographs shows the generally clean appearance of the CF 21 Another gives us an idea of the retractable landing goar and of the ready manner in which the engine coul can be opened up for maintenance purposes. There are many other features in the design which designe mention

Everybody knows that the polo's task in the modern plane is a heavy one, particularly because of the great number of metruments which he has to watch To reduce the difficulty of watching many instruments, a "fell-table" veiter in included and the indicator panel contains eight sets of lights which attract the polish attempts to light which attract the polish attempts to light immediately "fived Press Low." "604 press, Low." "Bank Selector 607, "Mixture Lean." "Low Prop RPU, "High Blower," "High Down", "Landing Gera Lip." These titles of the signals speak for themselves.

tutes of the against appear for undirective. The military polist now has a multiplicity of machine guns or even a cannon at his distriction of machine guns or even a cannon at his distriction. The polision of the polision

creates wealth and opportunity where they did not exist before. Whereas the old order was based on competition, the new order of science makes possible, for the first time, a co-operative creative effort in which everyone is the gainer, and no one the loses."

STATIC SUPPRESSOR

UNITED Air Lines, co-operating with Bendix Radio Corporation, have produced a static suppressor for aircraft use which scens to have buth promise. When the



chute and seat below, protect the pilot from gun fire from almost all directions

The detailed specifications of the C# 21 confinu the impression that a modern fight-ing arrigances are acceedingly complex affair, in which strength and aerodynamics are an important part but are far from convituting all the elements of the design —A. K.

pilot presses a button, an electrical device and a steel spring installed at the extreme rear tip of the fuselage release a wire into the shipstram which trails far helmed the auplane. The wire is of very small diame ter—smaller than the size of the sharpest point on the auplane. Previous experiments have indicated that static interference of

SCIENCE AND "THE MORE ABUNDANT LIFE"

SCIENCE has under possible a "new Jung under the sun"—the more abundant life generally distributed, voltout one ann having to make his game off another nan's boses. Re-earth in pure science must receive public support if this happy state of things is to be stabilized and extended These were the man theses of Dr. Karl T. Compton, president of Massachments institute of Technology, in his delives at the otherwise of Agriculture, Industry, Steme, reported by Steme. Struct.

In pre-scientific ages. Dr. Compton point of out, advanced cultures arose, but their brilliant accomplishments were always based on the exploitation of others. The Israelites gained their Promised Land only be externating the Canasanic nations alicatly in possession there. The Creeks and Ruman accomplated their mixels of art cause they had slaves in the back of the lones to do the hard and driv work,

"But there is something new under the sin," Dr. Compton continued, "in that modern science has given mankind, for the first time in the history of the human race, a way of securing a more abundant life which does not simply consist in taking it away from someone else. Selence really



The static suppressor for airplanes is installed at rear of fuselage

ferst result from the uncontrolled ducharge of state electricity accumulating on the wings and body of the airplane. With the trailing wire thinner than any possible discharge point on the rist of the plane, and a reassor to isolate the ducharge of the electricity from the vicinity of the airplane itself, aircraft static has been eliminated to all intents and purposes by its use. Of course, the anti-static loop aircram which we have had occasion to discuss before in these isolations are the static and the state of the s

portance of eliminating static when a pilot is listening for instructions or finding his bearings in bad weather cannot be overemphasized.—A. K.

NITROGEN

FARM soils in the United States cach year lose nearly 23 million tons of nitrogen through harvested crops, grazing, erosion, and learning, Only a little more than 16 million tons are given back to the soil in the form of fertilisers, manures, rainfall, irrigation waters, and leayme crops.

ELECTRIC EYE TRAINS FOR BICYCLE RACE

A "PHANTOCYCLE" went into training recently for the world's first hundred thousand-mile riderless hecycle rare, schedilled to start next May at the 1939 New York World's Fair.

In the test jun in the Westinghouser Research Laboratories at East Pittsburgh, this riderless bicycle, steered and balanced by a photo-electric cell, clipped off 28 miles an hour, and the research engineers said it was ready to maintain this pace in a 365 day sound, pacing off ucarly 400 miles a day.

Transparred by wires or braces of any kind, the beyele coasted along on three metal rollers, depending on the detrice ye and a team-mate called Silverstat to keep the wheel uppth Two corrective weights fastened respectively to the handle bars and front midgard and the groscopic effect of the hecyele's front wheel added stability to the roll rless wheel.

The electric eye is such a good rider that the heycle can bear a three-point adewise jurish against its saddle before losing its balance and falling into its safety catch. In fact, the electric eye is so good that it can steer the heycle without a guiter down steer row groove formed by the three propulsion

The "beam" ride starts when a light beam strikes, under the pedals of the bicycle, a mirror which reflects varying amounts of light on the electric eye as the bicycle tilts from its upright position.

Sensing the ulting, the electric eye transforms the light energy into an electric current which ja amplified and delivered to the Silverstat which, in turn, controls a regulating motor. This motor, actuated by the electric eye, steers the front wheel of the bicycle and moves the two attached weights to balance the machine.

In this apparatus, the engineers explained, the front when the bayed becomes a meaning own before the balancing weight has a meaning time to shift its position. The corrolis anticipate, and corrects the tilties to shift its position. The corrolis anticipate, foundable as its name could, is only a rotating flywheel capable of developing years, promoting to report the contract of the properties of the properties of the properties of the angular velocity of precession. In this case, the angular velocity of precession is the velocity with which the front wheel of the brevels is sterred to left of rails.

SELF-DIFFUSING INCANDESCENT LAMP

LIGHTING engineers recently welcomed a linew type of glare-free electric light bulb, called the most practical improvement in incandescent lamps since the appearance



Old and new: Self-diffusing incan-

in 1925 of the common inside frosted bulb. The new bulb, known as the Wabash Superlite, was developed by the Wabash Appliance Corporation.

According to Wabash, the new Superlite introduces light-conditioning in the bulb itself, producing soft, restful, surprisingly white illumination without the need for extra diffusing equipment or extra current. A new treatment on the inside of the glass breaks up the harsh raw light rays of the filament into soft, "counter-diffusing" light rays which are perfectly diffused over the entire bulb surface, and transmitted through the glass without loss of any light. Thus the "filamentfire" spot is eliminated, glare is stopped inside the bulb, and the light comes through perfectly conditioned for reading and working. All sizes of the Wabash Superlite, from 15 walls to 300 walls, are now in commercial production

RUBBER MOUNTINGS KEEP BELL IN BELFRY

I T looked for a while as though the new Baptist Church at Fries, Virginia, would have to break with tradition and install its bell in the yard But thanks to rubber, tra-



Bell mounting (in circle) to reduce

dition won out. The bell now reposes in the tower of the church and everyone is happy about the whole thing.

The difficulty first arose at the time when plana for the new clurch were made. The church already owned a fine 1900-pound held which they wanted to nee. The plana called for a tower of ample size to house the held but to build at heavy coungly to withstand both the weight and the vibration would increase the construction cost croasderably above the amount appropriated for the structure. In view of this, it was agreed that the bell would have to be installed in the clurch yard.

However, after the church was completed, the architect was again approached by the congregation regarding the possibility of installing the bell in the tower. He again refused on the basis that, while the supporting timbers of the tower were strong enough to hold the bell, the vibration created in ringing the bell would in time weaken the structure and might lead to an account.

Then one of the officials of the Washington Mills (large textile manufacturers located in



Ready to ride for a year, controlled by a photo cell



the same town) suggested that they try in staling the bell on rubber mountings As a result, it was mounted on four Vibri-Insulators supplied by The B. F. Goodrich Company. These rubber-to-metal, shear typemountings are designed to carry a maximum load of 500 pounds, so one was attached to each of the four legs of the bell frame.

Tests were then made and showed that all damaging vibration had been eliminated. Thus, rubber permitted a tradition to be inheld at small cost and with complete safety

CHLORINATED RUBBER ON ROADS

ADDITION of small percentages of chlormated rubber to the tar used on readsas a binder for their surface has been found to reduce the tendency of the tar to rini in the summer and to become britle in winter Tests of this idea are being made on British reads—D. If K.

WIRE ROPE FIGHTS

WHEN a gas-producing well "gues wild" the proceedings are not simple Experienced fire fighters are not to be found in every community and, before they can be brought to the seen, the dangers and difficulties of fire fighting may have increased many fold.

"Thus, after the valuable Rankmade Dr. velopment Company's No. 2 well bans' into flame in Rankm County, Missassippi, it de field all efforts until the famous Pation Od Well Fire-Fighters, of Houston, Texas, carm to the rescue. The well, which had been yielding approximately 30,000,000 enthe feet of gas daily, was by this time a blairing inferior The casing had apilit below the assembly of vives lamiliarly known as the "Christimatice." Gas, at high pressure, was burning como "Bannes not only making the fire externely difficult to fight, but also endangering the entire field.

Mr. H. L. Patton, president of the fire-fighting concern, who personally superintended the Joh, was confronted with quite a problem. If the fire was to be "snuffed out" by the usual method, it would first be nerewary to control the flow of gas so that it

Mushroom-like flames, bursting from a split casing of a gas well, above, were snuffed out, below, after casing was cut with wire rope



would rise in a straight column, or shaft of flame. This meant that the Christmas tree would first have to be cut off and the split casing cemented, and allowed to "set."

The heat was so intense that nobody could approach within 200 feet of the blaz ing well. Then President Patton had an in spiration. He bought 600 feet of \$\frac{1}{3}\text{-titto had}\$ an in spiration. He bought 600 feet of \$\frac{1}{3}\text{-titto had}\$ an inhalf had been strand Rope, together with large quantities of valve-grinding compound About 150 feet of the middle section of the rope was heavily loaded with the abrasive compound.

O L Patton, veteran fire-fighter, clad m

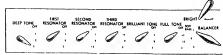
an asbestos suit, and with streams of water playing upon him, then approached closely enough to try to "lasso" the Christmas tree with the cable. After two vain attempts, the rope was finally thrown around the pipe below the tree. One end of the cable was held fast 300 feet away. The abrasive-loaded section was pulled right against the casing Then after a complete circuit was made, each end of the rope was made fast to a tractor The tractors see-sawed the cable back and forth until the pipe of the assem bly was cut off cleanly and the flame roared skyward like a great plume. With the split casing cemented and set, the plume nar rowed to a towering pillar. Mr. Patton had more than his share of grief on this contract One of the tractors used in the "see-saw" process broke down the only hridge approach for the fire quenching apparatus, and a road had to be built over a water-sogged field

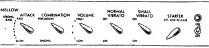
The "sunfing" apparatus consisted of a derrick mount on a trained it boom tail used a manifold, which was lowered and fast und over the pipe, the finance shooting out of its top By shitting off a valve, the own of out is top By shitting off a valve, the own some marrily diverted, the volves supply was cut off—and the first was out. Water was from injected into the well was constant to gas pressure and the well was receasing

NOVACHORD—NEW MUSICAL INSTRUMENT

A NEW measural instrument, the Nonchord, based upon the pungiples of what included the property of the transport of the puncies of the puncies of the sees Hammond were of off the Hammond organ. The new instrument holds a certain similarity to the pans and has here called an "electric orchestra," which is something of a misioner. While the Novachord can produce tones resimbling those of the modern orchestra, can even all upon the classic voices of the clavehord and harpschord to augment the resonance of the contemporary piano, it is in no sense an imitation of any thing

In form, the Novachord resembles the oldfishioned spine, having a single nasual keyboard of 72 notes which are played exactly as is a pason. It also has the regulation piano sustaining pedal and its volume is controlled by a swell pedal similar to that of an organ. But here the similarity ends Thetiones of the Novachord are produced electrically by means of circuits of ordinary assume tubes. A bank of 12 standard vac-





These two groups of controls are used by the operator of the Novachord

um-tube oscillators, tuned to the 12 halftones in the highest octave of the instrument, supplies the original impulses from which all other notes are derived. Each octave, except the highest, uses "duvider" tubes, the functions of which are to divide by two, exactly, the frequency received from the octavabove. In this way, the frequency of all the A's, for example, is controlled by the "A" oscillator in the ton octav-

The tones of the Novachord can be varied over wide ranges by means of simple controls mounted on the front panel above the keyboard. These, broadly speaking, are divided into two groups:

The group on the left controls the actual tone color by varying the harmonics. The group on the right varies the so-called "en velope" of the tone, a term used to describithe speed of attack and decay.

the speed of attack and decay.

The system works out in this way If the controls at the left are set to produce the same harmonics which piano strings produce and those at the right are arranged to give the same percussive "envelope," the instrument will produce tones similar to those of

if the offinary piano.

If the left-hand controls are set to produce the harmones of the violin and the right hand controls to produce a sustained tone, an effect of strings is produced with no change in the playing technique.

Hence, the latter-sweet voice of the obor, the soft nasal tones of the harp-schord and



The Novachord

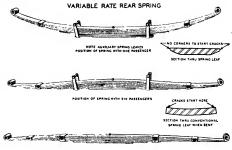
clavichord, the blare of the trumpets or the mellow ruminations of the French horn come forth accurately and without effort.

The music from the tone generator is amplified by conventional means and is heard through loudespeakers. The amplifying and speaking units are contained within the instrument, but for large installations where an unusual wolume of sound is required, additional speaking equipment to any desired extent can be connected to the Novachard

VARIABLE-RATE SPRING FOR CARS

EVEN as modern a mechanical 1 arvel as the automobile had its beginnings 17 centures ago. The search for better spring ing methods kept even the earhest vehiclevaginers occupied. The history of springs, from their lintroduction in the third century to their climax in today's "Duffex" rear springs featured on the 1939 Pontiac, showlong and pattent experiment.

The new spring is simplicity itself. To the conventional leaf spring, and directly below it, has been added a second but shorter leaf



1938 CONVENTIONAL REAR SPRING

spring For light loads the car rides almost cutterly on the main or upper unit which affords a low, confortable motion As the passenger load increases, this upper unit comes progressively more and more in contact with the lower spring As this occurs the rate of re-six ane to defeation builds upsmoothly until full contact between the two mist offers was maximum in-estance to di-

REDDER RED LEAD

A NEW process for the manufacture of A red lead is reported to yeld a pagmont of almost double the normal covering power and with a mine chalmord resistance to courseous. The new method consess in superiorizing lead in an electric as an adjusting bloom to pure oxygen where temperature and pressure are carefully controlled. Under this corrumstances red lead (Ph.O.) is formed of excellent quality — D. H. K.

FEWER TERMITES GET MORE ATTENTION

Is there more cancer, heart disease, and other disease today than there "used to be" or are modern facilities for reporting these diseases and gathering statistics simply superior to those that "used to be"? Many think the answer is the latter.

Similarly, today one bears everywhere that there is now a new pest on earth, the termite, which is likely soon to reduce all our wooden buildings to shells which may cave in at any munite. We have always had termite, however, It is true, though, that we have become increasingly termite-consess about many another condition that was once neglected but today is notized and fought against.

The United States Department of Agriculture has the following to say about ter-

mitre:
There are probably fewer termites in the country today than there were a generation or two ago, but these wood-destroying insects get much more public attention than they used to, Last year the Bureau of Entomology and Plant Quarantine answered more than 4000 requests for information about ter-

inites fuquiries came from every state in the Union.

"The number of termites has probably decreased somewhat, asys. R. A. St. Gorge of the United States Department of Agriculture. The decrease results, he says, from man's efforts to build homes in wooded areas, which necessitates the removal of trees, logs, and stumps—the natural food of the unserts and in some instances, the draming of most areas. This termites are deprived of their able, nam requirem in, water,"

GAS-FILLED CABLE AN OUTSTANDING DEVELOPMENT

I OW. GAS PRESSURE, cable, most recent unitational development in its field, is amounted by G. B. Shankim, engineer of the eable section of the Gratical Electuc Company in the new cable, less insulation in the solid type of construction. As a result, in the solid type of construction. As a result, in the solid type of construction, As a result, and the solid type of construction in cristing duct systems without enlargement of maintained and produced the solid type, in cristing duct systems without enlargement of maintained and produced the solid type and the smalled diumeter and possible use in smalled editions of the gas field eable will assure as the construction of the smalled diumeter and possible use in smalled thereto if the gas field eable will assure as formerly the gap between the optimization arranges of the solid type and the old filled

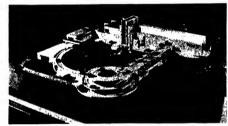


Gus channels in a new cable





The "roads of tomorrow" are being built today. Above; left: The Kew Gardens loop on Long Island and, right, the Pulsaki Skyway in New Jersey. Below The Ford exhibit at the New York World's Fair, in which is half a mile of road



constructions. The new product is almost aseasy to handle in the field as is solid-type eable, and splices are simple. The adjustment of gas pre-sure can be handled conomically by gas re-ervoirs when conditions require them. An alarm system can be installed to detect gas leakage.

stand to uteled gas reacage.

The general essentiation of the new calleis quite similar to that of the ad-filled advisible and which are not worldy used. The principal
difference is that instead of Jeong filled with
difference is the timester of Jeong filled with
effects the filled with a neutral gas,
nuturgen, under a moderate pressure (10 to
15 pounds per square inch), in line with its
intention of filling the gap between two
varlier types of cable construction, its op
erating valuage stress, in value per mil, is not
as high as that of the ol-filled type but is
ended to the pressure of the construction of the
considerably higher than that of the conventional solid-type impregnated-paper in
solated cable.

"THE ROAD OF TOMORROW"

ONE of the most significant steps in the development of modern highway construction is the consideration now bring given by several state legalatures to the building of "freeways." Such routes were first proposed a few years ago but very little progress was made in having then generally adopted until New York and Rhode Island

passed the required legislation to enable their state highway departments to construct them. Among other states which are considering legalizing this type of road are California, Connecticut, Massachusetts, Maryland, and New Jersey.

The basic essential of the freeway is a right of way to which abuting property desend have access. Because present traffic in hulling areas is showed down to an average of 15 miles as hour because of sophights uccessfy to control it while to essential to a control of the cont

Another major trend in ande express highway construction is toward elevated highways which separate local and express while inter traffic or all mostered traffic from pedestrians. Such highways provide for a counplete physical expraration of upposing streams of traffic, chiminate direct access to abutting property, climinate intersections and incidental cross-traffic, and separate ped-strian and vehicular traffic but haterally and crossand vehicular traffic but haterally and cross-

Taking a lesson from engineering experis who have definitely set the pace for elevated roads, the Ford Motor Company has constructed "The Road of Tomorrow" as an integral part of its Exposition building at the New York World's Fair. This road, which is more than half a mile long, rises by a spiral ramp from the ground level to a maximum height of 33 feet. Over it visitors to the Fair will be driven in cars around and through the hindring at an elevation which propher ically demonstrates the treat toward the day when vehicular traffic will be separated from pedestrian traffic.

"The Road of Tomorrow" will be teached from the patio of the Ford Building by short starts to a loading platform which will be provided with tables, chairs, and imbiellas. The ride itself will be a delightful advin titre, affording the passengers an unexcelled view of the entire Fair grounds and the surrounding countryside.

RUBBER MOLDING POWDER

A RUBBER powder containing about 96 percent rubber and having interspection and unvel projective has been preduced in the government experiment station in Java The new product, called "Medical Section of the control of the control

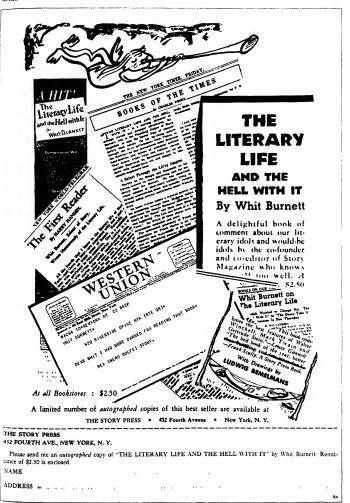
ALLOY HARDENED AFTER

FABRICATION

E ASILY fabricated in its soft state, a new nickel alloy takes on a high degree of strength and hardness following simple hardening treatment. Also, it possesses high corrosion restance. This "27" Nickel (98) percent nickel minimum) is now offered in various fabriested forms and different degrees of temper by the Driver-Harris Company.

In the unhardened or quench-annealed state, "2" Nickel is as readily worked as nickel, including bending, drawing, maching, and hot forging. When heat-treated, however, at low temperatures of 890 to 930 degrees, Fahrenhell, it attains a hardness of Rockwell C 33-45, at which levels it is 2½ to 4 times as strong as structural earbon steel and possence good touzhness.

times as strong as structural carbon steel and possesses good toughness. "Z" Nickel is being fabricated in colddrawn rods, wire, and cold-rolled strip, in a wide range of sizes. Such forms are avail-



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(Revised List)

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able in soft, half-hard, and full-hard tempers to meet intended fabrication and appheation requirements. Since the extremes of initial softness and ultimate hardness determine the full value of this alloy to users, exceptional care is taken in rolling and drawing operations

The new alloy finds many applications, already including coil springs, spring clips, wire brushes, hand tools, and other items. it lends itself particularly well to deep drawing of parts that must withstand exceptionally hard usage

HAND POWER-SANDER

BRINGING new speed, efficiency and convenience to metal and wood workers, a nine pound, portable electric belt sander has just been announced by the Syracuse Guildtool Company, Featured by its handy compactness and moderate price, this new power tool was especially designed to make available to the average workman the advantages



of the belt-type sander, and to eliminate the costly drudgery of hand sanding, surfacing, and refinishing

Light in weight, the GuildSander is usable in any position. It has the power to do all types of sanding and the adaptability to sand all straight or slightly curved surfaces. The front pulley may even he used as a spindle sander

In quality, the GuildSander conforms to the recognized standard of larger and much costlier portable sanders. It is hult with a die-cast aluminum frame, finished in baked aluminum enamel. The abrasive belis are of the endless type, and travel 600 feet per minute. They are two inches wide by 21 inches in circumference, and are furnished in all usable guits. They may be changed quickly

The GuildSander is equipped with 110-voli universal motor that plugs into any light socket.

BETTER SPONGE RUBBER

April '39

NEWEST adjunct to comfort is foamed rubber latex sponge used in upholstery, mattresses, and various cushion ap-plications. This interesting material as produced consists of a hardened froth of rabber formed from latex, which is the milk of the rubber tree and primary source of all natural rubber. The process of manufacture begins with a concentrating operation to increase the ratio of rubber to water in the latex by passing it through a centrifugal similar to a cream separator. To

the concentrated lates are added sulfur and other computed accessary to its subsequent and a forming agent to aid or computed and a forming agent to aid or common of a froth. The compounded later is put in a beater similar to an egg beater or cram whipper which converts the hick liquid into a light, airy froth. The first has stabilized by the addition of a gelling agent and is then vulcanized in a mold unnersed in hot water at approximately 205 degrees, Fahrenhett, for the length of me required by the particular compound to being used by several leading rubber manufacturers under hereas.

The principal application of foamed lates, some is in cubinos, matterws, and up-loi-step, but in addition it is finding important uses as a shock absorber and enshioning agent in industrial machines. This method of making rubber spong is much simpler than older processes which depend of upon the generation of a ga in small bubbles within a doughty mass of rubber,—D $H\ K$

AROUND THE EARTH WITH A SINGLE POUND

W EIGHING 0 00000009246 of a pound per foot, the aluminum wire shown in our illustration compared with a himan han is not a freak or a museum piece, wire of



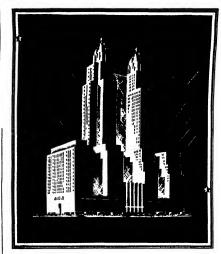
this diameter is used in string galvanometers for geophysical research and prospecting. The wire has a diameter of 1740,000th of an inch, and a single pound of aluminum could be drawn into 20,000 miles of such wire The cost, however, would he almost \$500,000 for that pound.

SOAP BUBBLES FOR GROWN BOYS—AND FOR

ENGINEERING

As a lad you probably blew one bubbles. As he was an adult you might like to try at again with a better coap solution, making bigger, more lasting bubbles possibly inflated with hydrogen to make them float or to explode when ignited, especially if you could do at ostensibly for the amusement of some youngset: In the Journal of Chemical Education, G. A. Cook of the well-known Case School of Applied Science, Cleveland, Ohio, summarized the technique and showed with those bubbles of our "kid" days were not so good as some that can be had with a chemist's knowledge of the subject.

After much study of existing literature, including two_excellent books that are available (C. V. Boys, "Soap Bubbles, their Colors and the Forces Which Mold Them," 1924;



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siso A. S. C. Lawrence, "Soap Fillms," 1992), the auther made numerous experiments which are described in his article, and finally reached the conclusion that a solution which can be prepared from materials readily suitable and in a minimum of time, and which will yield binblies lasting from one to five mutures in the open are thubbles in closed vessels lasted as long as 100 days), a made as follows:

An ounce of powdered Castle soap is placed in a one-quart botte filled with distilled water (available at most drug stores and filling saiston). The bottle is shaken at micrads minil solution is complete, and allowed to stand for 2's hours or longer. The clearer part is then sphoned off and the rest known away. To the clear portion, tirrecteaths of its volume of glycerine is added and theoryship with which was a standard throughly mixed with it. The bottle must be stored in a dark place and at all times, kny will stoppered. When it is desired to use the solution, about 2's cup of the control of the

The article also describes the use of a new kind of soap called triethanolamine, for making flat soap films which last for several Such films are important in research on au plane design and in the design of many kinds of machinery, because of an analogy between the tension, or stress, undergone by a structural member, such as a beam, and by a soap film stretched across specially shaped supports and strained by a blast of compressed air. Thus, the strain that would be experienced by certain parts of an air plane, for example, can be predicted without actually building the unit, and the best con struction for a given need can to some ex tent be determined beforehand. The article gives references to papers in which work of this kind is reported and explained.

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W HO doesn't like smoked turkey? Who does, you retort, and a good retort it is, for few are aware that this delicacy can be had in America. Turkeys cured, then smoked and cooked at the same time are sought after by the gournets of this country, and the only source of supply, Pines bridge Farm (in Westcheart County, New



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A turkey smoke-house

York) is kept busy shipping its product all over the country.

The process is secret, and begins with a special cure carried on in a refrigerated room From there the turkeys are taken to the smoke house for smoking and cooking The re precise regulation of heat, ventilation, and smoke is essential In a matter of minntes a whole houseful of fowl may be arretrievably runed if the attendant relaxes his attention.

For the last three years this farm has supplied smoked turkeys to the Waldorf-Astoria, Colony Restamant, The Stork Club, the steamship Queen Mur), the crack 20th Century Lamited, and many other exclusive restaurants, night clubs, and establishments, and has filled orders for individuals whose names read like a page in Who's Who.

What is this secret process, and why cannot anyone smoke turkeys? First of all, the hane in which the turkeys must be cured after drawing their contains eleven herbs and spices, some very rare and obtainable ouly from a particular house in London specializing in them. During curing, and afterward until they are taken to the smoke houses, the turkeys are kept in a large re-frigerator at a closely held temperature of 40 to 42 degrees, Fahrenheit, with the air circulated through the refrigerating units by powerful fans, and with all possibility of contamination by the mold of decay or the hacteria of disease chminated by use of the Rentschler James Process, which uses ultrasadet sterilizing lamps. From this refrigerator, birds are taken as required to the smoke houses, where they are hung over a wood fire This fire cannot be made of just any wood, for the kind has an effect upon the taste of the meat. It has been found that apple wood is the best, and the farm's operator scours the nearby countryside for old apple orchards, which he buys and cuts into cordwood

ACETIC ACID IN PETROLEUM REFINING

DURING recent years numerous solvent processes have been introduced for the refining of petroleum. The latest of these, developed in India, uses glacual acetic acid as the solvent. By adding water to the acetic acid solution it can be given a solvent power varying at will. The principle of operation



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of this refining method is to dissolve part of the oil, leaving the rest undissolved. In this way separations can be effected which are difficult, if not impossible, by distillation or other methods independent of solvents—D. H. K.

WHY SOME BIRDS

MOVE THEIR HEADS

THE vision of most birds is monocular, the visual fields of the two eyes bring quite independent of each other. Monocular vision with two evex, each having a short focus, wide angle lens, has the advantage of giving a sharp and distinct retain image of everything value two large vision fields but in his the doadvantage of recording that the properties of the doadvantage of recording to the doadvantage of the

This disadvantage is overcome by the horizontal had movements of such birds as the doves, pigeons, coots, and gallinules and by the vertical lical movements of the adore hirds, Suth head movements provide a hase line from which distances may be measured, and the hidting out of the image between the extremes of this base line, assuming a returnal lag, results in a steroscopic effect.

Thus the hirds, under the apparent physical handicap of monocular vision, in reality, as a resultant of the movements of the head, possess all the advantages of binocular vision, in addition to the advantages inherent in double monocular vision.

Although it is believed that the attainment of the advantages of binocular vision is an important factor in the head movements of birds, it is not assumed that it is due in the only factor, or that it explains its origin. Austin H (laik, Zoologist at U. S. National Museum.

FIREPROOFING WITH

PAINT

BRITISII chemists have recently developed a paint to be applied to wooden structures to reduce the hazard of fire from incendiary bombs should a war occur. The paint localizes the fire produced by the bombs and has proved successful in small scale tests—D. H. K.

DROP-IN COOLING UNIT

ROGINEERS of Frigidaire Division, General Motors Corporation, have developed a new "drop-in" milk-cooling unit which can be installed in any standard type of milk-cooling cabinet, it was announced recently.

The new unit consists of a cooling coil and motor driven water-circulating device enclosed in a cylindrical steel shell. The cooling coil is connected to and refrigerated by means of a Frigidaire compressor.

The unit is shipped from the factory as a complete assembly which may be readily installed in an old or new milk-cooling cabinet and plugged into a convenient electrical outlet.

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ing to temperatures below 50 degrees as required by many states is also insured, thus retarding liacteria growth and eliminating spoilage and rejection loses.

The unit is completely automatic in operation, climinating the labor required by old style cooling systems. The new unit is available in two sizes for cooling two to six cans of milk per day It is ideal for the requirements of the small darry.

EFFICIENT COPPER-OXIDE RECTIFIERS

COPPER OXIDE rectifiers having a ca-A pacity of 3000 amperes at six volts are now being economically used to supply direct current in an electrotyping operation Recufiers of this type have been used for many years in various applications requiring relatively small amounts of electric power The present installation is the first in the electrotyping industry, and during approxmately six months of operation has proved itself both efficient and economical. The initial cost of the copper-oxide rectifying system is approximately half that of a motorgenerator installation of the same capacity, and since no moving parts are involved it has no sendency to wear out. The alternating current as purchased is passed through a transformer to bring it down to the low voltage required and the current at low voltage is then rectified.-D H K.

FINDING METEORITES

SPECIMENS of 70 meteorites have been added to the collections of the Smithsonian Institution, at the nation's capital, during the past year, 62 of them representing new falls. This brings the Institution's total number of meteorites to nearly 700, or more than half of the known meteorises reported to have hit the earth. The largest specimen acquired last year weighs close to 90 points and the smallest only a few grams

The Smithsonian is eager to obtain as many as possible, is actively engaged in building up a great collection of these meteorites for study, and encourages people to search for them. The students of meteorites to a large extent depend upon the chance discovery of them by the people throughout the country, and to stimulate the search, the Smithsoman rewards the finder.

Meteorites are all very heavy for their size, and much heavier than the average rock on this earth, the reason being that they sometimes consist of an alloy of iron and nickel, usually over 90 percent iron. When the stony

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No meteorites contain any metals worthy of the cost of recovery. Their value lies in the sociation fifte information they contain which can only be obtained by careful laboratory study of their structure and composition.

HARD PAPER STATUARY

SCLIPTORS have been provided with of a new modum for their at moth form of paper pulp hardened with synthetic resurfier product known as "hard paper" is about as hard as hotwood and has a unit form, non-deriventual grain throughout Promoters of the sides expect thas no medium to compose factorably with stone, non, honze, and other materials used by "supports" D. H.

FIRST AID FOR MOTORISIS

It automobile manufacturers would supply an illustrated first aid handhook with every car, it would help to cut down the thir sun! In too frequently deastrons results following automobile accidents. This proposal of a list and handbook with every automobile was made by Dr Chailes S Vernable of San Antonio, Tevas, at a meeting of the sunthern Method Association of the southern Method Association of the southern Method at Association.

The hidding jack handle in every can makes a good arm or leg splint, Dr. Vendils and but infortunately John Q. Public does not know this Neither, Dr. Vendile pointed out does Mr. Public know that a pine of fence or a small limb from a tree can be used for a splint.

Instead of using mith handy objects, he in Akadis a per perion with ger hack holeen in Akadis a per perion with ger hack holeen in Akadis and perion was result in McGong doublidy. Or the travel with the braken hack doubled my into the real seat mested of heigh left fall in the ground till an ambidiance councy, ar new at the hospital with his spinal cord critical and may be paralyzed or de If the patient with broken hack on necks skept in a fall, horizontal position. Dr. Cenadle explained, he has a good chance to recover without doubling v-Stream Setting.

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FABRICATING Non-Ferrous Metals

NEW process which makes possible precision shaping of non-ferrous metal-

and plastics, in sizes and designs which form erly could not be produced, has recently been introduced on the market. It literally begins where methods of extruding or rolling end, for it produces, in any length rods, designs too complicated and sizes too small to be se cured by any other known method

Underents, which litherto have frequently proved an insurmountable obstacle in con truction, are entirely solved by this method Precision, too, can be held down to .002 incli, and even less, if required

The accuracy and multitudinous designs which are possible by this new process can he quickly produced, at low cost Scientists, engineers, and designers can, by this process, without prohibitive cost of dies or mill ing work, immediately have almost any conceivable shape made to order in the shortest

In the automotive field alone, many designs which have hitherto defied the skill of productive and tool experts, can now be manufactured with surprising facility.--(F. Greeves (arpenter

Answers to Problems

The answers to the problems proposed on page 219 are as follows:

Crossed ladders: 27.87 feet. Spheres: 0.74048 in elther car ice the ratio is the same for balls of any diameter.

Barge: 4.660, 4.012, 5.166, 4.518 feet: pressure is 38.73 tons. Dog-rabbit I: 91/1 sec., 6.105 sec. Dog-rabbit II: 3.717 sec. 68° 36' 54" east of north.

HERE COMES TELEVISION!

(Continued from page 209)

eliminate the event of going to the theater. Television, however, will probably make use of many films, either shorts or films made especially for television.

I am not eminently qualified to speak on the subject of the television receivers that are soon to be marketed. I assume, as I have said, that they will be reliable. There will probably be both table and console models. embodying several sizes of Kinescopes-perhaps five-inch, seven-inch, and twelve-inch tubes. The largest of these gives an image approximately 71/2 by 10 inches in size. Almost all of the models will also reproduce the sound associated with the picture; but it may be that the less expensive models will require the addition of some form of ultrashort wave adapter to the radio receiver al-



CAN MAN REACH BEYOND THE VEIL?

On the Edge of Eternity

To close and yet so far from Sthe source of all is man. Are we allowed but a fleeting glance at the universe-just a conscious interim on the stage of life-a brief look at the setting, the stage, and our fellow players? Must each minute be lived regardless of what it affords, or can life be an intelligent choice-a time well used to gain a desired end? Not alone in the vapors of test tubes, or the misty yords of the telescope, will man find the answer to the riddle of life and that course of living which brings mastery of self and happiness, but in the depths of his own being

The surges of self which the emotions well up within you, the flexhes of intuition which hreak through your consciousness in spite of superfluous interests are the signs which point a way to contact with infinity -the primary cause of all. Certainly you are not-nor are men generally-averse to brilliance of mind, to creative ideas which make for accomplishment, and have their worldly counterpart in demands for your personal

services and success in any en-

Therefore, let the Rosicrucians (not a religious organization), and age-old, world-wide fratermty, reveal to you the simple methods used by the sages and master thinkers of yore for shaping the elements of your environment into a world of personal achievement. This knowledge goes beyond mere faith or belief. It is the ageless science of life, which has accounted for most of the world's greatest thinkers and doers.

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sound to accompany the television image. It will seem to many that the largest size television image now practically obtainable will still he far too small for home entertainment needs A comparison will be made between television's images and those of the motion picture. The habit of viewing scenes on a large size movie screen will probably prejudice many persons against television's present images. I believe, however, that most persons will be surprised at the amount of interesting detail that can be portrayed in the larger size television images. It must be remembered that the television image should be seen at the proper distance. At a distance of five feet the eye subtends the same angle at the television serien that it does from the rear row of the average motion picture theater. Experiment on devices for producing larger images by projection methods is un der way The present projection tube, with its associated apparatus, is still too compli cated and combersome for home use

There will also be many persons inchned o "wait until they perfect this thing" before they consider the purchase of a receiver They will feel that there will be rapid obsolescence in the receivers, that perhaps standards will change in a short time and render the receiver that cost perhaps several hundred dollars a useless piece of furniture

This factor of obsolescence is certain to count rather heavily What assurance can we give against rapid obsolescence? Tele vision has been long in developing and has progressed through an evolution that has seen many methods and standards tried and discarded. If a single set is to tecewe the programs of all stations within a given ser sice area, uniform standards must be set un for all transporters

A subcommittee on standards of the Radio Manufacturers Association has tussled for years with this problem. The British, in 1936, established a public television service in the London area, operated by the British Broadcasting Corporation and financed out of receiving set heenses levied on every radio set We in the United States have fol lowed the success of the British standards, adopted those which proved their value and rejected those which to us seemed inferior to those proposed and tested here. For more than two years the NBC station in New York has been a proving ground for many of these standards. Now the body of standards proposed for an American public service in tele vision has been adopted by the radio in dustry and recommended to the Federal (ammunications (ammission They repre sent an advance over those prevailing in

Britain. Here, I believe, lies the answer to those who feel that we are starting television broadcasting without adequate study and preparation The adoption of these standards was not precipitate. For technical reasons, if for no other, American television has been delayed to assure the adoption of the best possible group of transmission standards. They were arrived at without prejudice to anybody's claims and I feel certain they offer the enduring basis for Ameri can television I feel certain, too, that they will not soon be modified and that receivers based upon them will give years of satisfactory service to the first buyers.

But, after all, the best way to judge television is to see and hear what it offers. Take a look at the images when you can. I think you will be as enthusiastic as we are,

Books

SCIENCE FOR THE CITIZEN

By Lancelot Hogben

TEW of the writers of popular books of the type that treat the several sceneres from settmenty and physics through to the hological branches are capable of coupling their preventation with penetrative interpretations of the social significance of these advancing sceneres, but Hoghen's new book combines this feature, in a work that hids fair to become a best seller, like his "Mathematics for the Million." Thus the reader for student, for the book is partly for reading and partly for a little harder study) will come to understand much more than the mere fast-cultering kind of person—he will comprehend the significance age, sience as dunking prople of 1002 pages.

U.S. CAMERA ANNUAL

Edited by T. J. Maloney

IT is impossible to describe in the short space of a review the wide range of pitoral material presented in camera annuals, of which U. S. Gamera has become one of the outstanding examples. Probably the most portioned thing that we can say about this particular volume is that Edward Steeken was the sole judge in selecting the photographs which are presented. Of by 12 miles, 1909 pages of photographs and descriptive material plus an advertising section strategies are the proposed of the properties of the propert

MONEY-MAKING HOBBIES

By A. Frederick Collins

THE author has collected in this volume a large number of hobbins which can be turned into money, including the making of toys, tools, and so on, from paper, textules, and Cellophane; the making of pottery; wavang, leather tooling, woodwarking; model-building, electro-plating; metal work, and printing. Included also are money-making entertainment hobbins and, of course, photography finds an important place in this book, 1322 pages, 5% by 7%.) –82.10 post-patd—F. D. M.

THE ENDLESS QUEST

By F W Westaway

HISTORIES of science are abundant but the very word lustory frightens the average reader; he thinks of the dry bones

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SELECTED BY THE EDITORS



of things long since gone Books of general science treated non-historically also abound The present work, however, is a compound of the two, but the bones are not dry It is an account (very exhaustive - over 1000 pages), of the growth of science, in which its many discoveries and theories are fully explained by a notably fucid writer. The "endless quest" refers to the past 3000 years of science but the reader reaches modern seience before he has covered a third of the book, and the current science of our own times is well explained in all its main branches. A truly remarkable compendum bright and friendly, never dull or labored (1080 pages, 5% by 8½ inches, 241 illnstrations) -- \$3 10 postpaid - A. G. I

BEWARE FAMILIAR SPIRITS

By John Mulholland

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THROUGH THE OVERCAST By Assen Jordanoff

AMATEUR avaiors, professional flyers, recryptor connected with or interested in the rapidly advancing science of avaiton will find here a complete and welcome treatise on what is generally known as "hind flyer," Instrument flying, the bases of this chitze book, has become such an essential part of modern art transportation that a book of this sort fills a very definite need. (356 pages, 8 by 10½ mehrs, theroughly illustrated with pen and ink drawings)—83.10 postpald—A. P. P.

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By Giorgio Abetti

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scopio observation, the outer envelopes, physical constitution, radiation and temperature, the Sun among the stars, and the Sun and the Larth. The author is a noted Italian solar physicist and his book is dicticated to the late Professor Italia (300 pages, 5½) by 9 mches, 157 illustrations.)—\$5.10 postpaid—A. G., 1

HEARING-ITS PSYCHOLOGY AND PHYSIOLOGY

By S. Smith Stevens, Ph.D., Dept. of Psychology, Harvard, and Hallowell Davis, M.D., Dept. of Physiology, Harvard

AN outstanding work, in fact a landmark since it summarizes between two covers the results of the great wave of investigation into the physiology and psychology of hearing made possible by the application of radio amplification technic to this kind of research The book has an introductory section on the fundamentals of the science of sound, with a minimum of mathematics; then it deals with what is heard when sound reaches the ears; next with the relation between stimulus and sensation, and then how it is heard (the functional anatomy of the ear is included in this part). While not a popular work, it is not too technical for thousands of studious laymen eager to comprehend the new knowledge of hearing (489 pages, 5% by 9 inches, 165 illustrations) -\$1.75 postpaid - A 6 1

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THE TEXTURE MATRIX

BOON to the miniature worker and A the fine grain problem, and offering an opportunity to all photographers to in troduce surface texture effects not inherent in the printing paper, the so-called texture screens are finding a wide public William Morteusen, with his steel engraving texture matrix, is probably responsible for bringing the method into the vogue it enjoys today That his lead has been followed by others is indicative of a growing interest among amateurs desirons of improving the surface appearance of their prints

Recently, we had an opportunity to try

out the latest variation on the texture matrix theme, namely, the Dia-Matrix Screens, which are available in three textures. Tap estry Bromod, and Charcoal Of the three we personally lean strongly toward the last as offering the most for one 8 money in the final appearance of the print, but that will doubtless be disputed by other users of the screens, who may prefer the other two

The servens, which are available either in



from an enlarger. Closest contact is achieved through the use of a regular printing frame, but no hou of this a sheet of glass may be cuployed The printing frame is to be preferred for the obvious reason that unless there is absolute contact between screen and paper, uneven impression will be the disappointing result.

There is no hard and fast rule as to what constitutes the correct printing depth when employing these screens, for the degree of texture imprinted on the sensitized paper



"Straight" enlargement

the 8- by 10-inch size or the most common salon size, 11 by 14 inches, are individually hand-made and spotted. Like photographic film or paper, the screens have an emulsion side, on which the texture markings have been applied, and a plain, untreated side. In use, the emulsion side of the screen replaced in contact with the emulsion side of the sensitized paper on which the print is to be made, the uncoated side of the screen facing the negative image projected





varies with the subject, the amount of image detail one desires to retain, the general effeet aimed at, and other factors For large heads, for example, a longer printing time may be allowed and a consequently charer, that is, darker, impression of the texture achieved, than might be the goal where a landscape is involved. In exposing the examples shown on these pages, printing time was three and one half times that required for the "straight" enlargement. And this seemed to be about right for the subject. Also, different paper surfaces will make for dif ferences in the comparative effects achieved with these screens. In general, it may be assumed that semi-matt and matt papers are the most suitable.

Boudes the surface of the paper and the length of the exposure, the degree of tex-ture may also be controlled by the type of developer used. A brilliant negative is recom-mended, though it is held that any good segative, whether contrasty or soft, will yield satisfactory results, employing a continsty print developer and a contrasty paper for the former, and a soft paper and soft print developer for the soft negative.

The screen markings being naturally mest evident in the shadows, one must be sure to print long enough to imprint the texture in the brightest highlights. The heginner in this work must guard against a certain timidity in this regard for the texture unpression must inevitably call for a darker print then would result without the use of the screen.

Owing to the necessary coarseness of the screen impression, which is due to its hand-worked appearance, opportunity is af-forded for sketching in little changes here and there. For this purpose an ordinary lead pencil may be employed.

FOUNTAIN PEN FLASHLIGHT

IT'S not sold as a photographic accessory but there's nothing handler for some darkroom purposes than the inexpensive little flashlights shaped like fountain pens which you probably have seen in the stores. Immediately ecoming to mind is its use for "flashing in" dark areas in a print during enlarging. Those light or meaningless areas that interfere with the effective presentation of the main subject in some prints are thu conveniently snuffed out without affecting other portions of the projected image. The clip will which these devices are equipped makes it possible to have the flashlight always handy as it can be carried in the pocket alongside one's fountain pen

FLASH SYNCHRONIZATION Trerra

MAKING possible a regular program of checking the synchronizing outfit, a new testing device for the purpose of cheek ing the relative timing of a camera shutter with the flash of a flashbulb has been made available by the General Electric Company in the G. E. Synchrograph. The Synchrograph consists of a case with an aperture at each end, a film-helding chamber taking 4-by 5 film, a retor which is twirled by means of a knob, and two simple optical systems by which light entering at the apertures is directed to the film through shits near the respective ends of the rotor. The device may be used in any ordinarily lighted room

In use, a Photoflood both is placed immediately behind the ground-glass focusing screen, the lens board of the camera is racked out so as to position the lens close to one of the Synchrograph, and Photoffash lamp is placed in the other sock-et, the cord being plugged into the socket of the synchronizer The Photoflash lamp is placed in line with the other aperture of the ynchrograph, and a shot is made

Development and fixing of the film in the usual way will reveal one of three conditions. Shifter opens at peak of flash (cor reet synchronization), slimiter opens ahead of peak (thin or blank negative, synchron per needs adjustment to delay opening of shinter), shinter operates later than the best part of the flash (should be adjusted to open sooner).

SMALL STOPS AND DEFINITION

THE widely held notion that the smaller the stop the greater the definition afforded by a lens is disputed by Hford, Ltd., of England, who support their stand with the accompanying photomicrographs which are from very fine line printed originals first set of lines shows the definition at f/20; the second set, the result when stopping down to f.'40, and the third set, the result



at stop f/80. While the difference betw 1/20 and 1/40 may not be so clear in the scaled-down reproduction shown here, it is very apparent as between f/20 and f/80. The conclusion is that the relatively large stop of f/20 gives better definition than f/40 and much better than 1/80.

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> Watch For the Complete Rules of the Contest, to be Published in Our May Issue

Closing date December 1, 1939

So You Want to Take BETTER PICTURES

By A. P. PECK
Associate 1 ditor
Scientific American

THE book you need to get the best results in photography

QUESTIONS that you want answered, things that puzzle you, all are explained in simple, straight-forward style, free from technicalities. Written for those who have their developing and printing done by the photo shops.

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"This applies to all types of lenses," say the Hisrof people, "and arises from the differacion of light which occurs at the edges of the step and has nothing to do with the photographic material employer differation which causes light to he exattered beyond the edge of the image and so produces the ill defined edges sometimes found in practice.

PHOTOGRAPHING WINDOWS

BY DAYLIGHT

IF you should even have occasion to photographs a de-play window during the day, whether for how on noney, here a superpose of the property of

BLUE TONING OF PRINTS

A WIDELY used formula for the blue toning of prints was recently published in the Zersy Magniture. The formula, for usonly with chloride and chlorobromide papers, follows.

Gold Chloride Blue Toning Formula

| Value | Solution A | 250 cc | 8 oz | (cold Chlorade | 1 gram | 15 gram | 5 olution B | Value | 250 cc | 8 oz | (citin Axid | 3 grams | 50 gr

Solution (
Water 250 cc 8 oz
Thiocarbamide (Thiourea) 3 grams 50 gr

These are solve shiftons. A working solution to one three II- by 14-neh prins consist of one ounce of each of the above solutions plus tra ounces of water, the work of path lenng used at 65 to 70 degrees. Tourne commences in five munics to a half the properties of the contract of the contract of the principle of the contract of the two boars. Against during toiling for even action of the bath and wesh afterward for a half hour.

The prints must be washed well after faxing and before toning and again after ton ing; prints must be fixed in a plain or acid fixing bath without any hardening agent, and prints must be so exposed and developed as to be lighter and have less contrast than is desired after they are historied. Also, different tone depths will be obtained with different paper developers.

BACKGROUND ON HOOKS

O'UR sur-ly-vax-foot background (stretch of on a wood frame), supported by projecting woods "Lin" at the sides, had been standing on the floor of our studio for a long time when a watting friend objected the strength of th

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IN PHOTOGRAPHY

and still



On hooks

ground from the walls, with a pair of hooks at each self. Out all hat full-figure pictures, the background was high enough, being separated from the floor by only a few inches. For full-figure portrait, or similar short, the background could easily be lifted off the hooks and stood on the floor at a slight duan, with the wall as a support That we thought the idea a swell one is attested by the accompanying photographic proof.

Panatomic-X in Larger Sizes

H ITHERTO available only in the 35-mm peative size, Panatemic-X may now be had in a wide range of roll film and film-pack, sizes. The manufacturer recommends this cut film as an all-around emilsion, in-clinding the requirements of copying photographs, half-lone reproductions and documents, technical photography, and salon and exhibition would.

FERROTYPE PLATES

THIUMBING throught the entrent source of Studio Light, the Eastman Kodak Company's house organ for professionals, we found a suggestion concerning ferrotype plates that should help the anatu ra swell. It will be real news to many that ferrotype plates, which are frequently washed and upon which wer prints are placed to dry, may actually be damaged by water.

actually be damaged by water
"Some enumers," says the writer, "are totally impersons to water, but the particular
enamel used for ferrosty pilates is not After
these plates have been repeatedly allowed
to stand in water for considerable lengths of
time some of the mostine penetrates the
enamel, rusts the metal beneath, and causee
small bisters and uneen surface roughness.

This, of course, ritins the plates."

The advice is, first, not to allow the plates to soak in water for hours at a time, and, second, never to set them away to dry with drops of water on them.

ADD PHOTOGRAPHY

INFLUENCE

W/E don't know where it is all going to that photography is still poking lis none into activities outside its sphere. A Fifth Avenue store, for example, was, at the time of this writing, dramatring, newspaper-tire, and using press cameras to put the story over. In each of a half doesn or more windows was a Speed Graphic camera, with synchronizing flashing attached—taklart, Alb



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bey, Mendelsohn (playing no favorites, you see)—and an 8- by 10-inch plate-holder on which the appropriate advertising legend was written in chalk—or was it white ink? Attracted plenty of attention, too.

Another non-photographic activity that in cluded photography, nevertheless, was the annual National Sportamen's Show at the Grand Central Palace, where a candid camera contest was held in connection with the program. That helped, too

ARGE empty spaces in the home can be

FOR LARGE WALL SPACES

A beautifully utilized for hanging your best photographs by constructing a more or less permanent "salon" wall. Purchase a sufficient length of monk's (or friar's) cloth, which comes 50 inches wide, to cover the area in question. You may, of course, have your "salun" any width or length you desire or your facilities can accommodate Next purchase some molding of plain design and ave it cut and mitred to fit the two long sides and the two short sides of the "salon, Tack the cloth on to the wall, driving the tacks as close to the edge of the cloth as possible, pulling the cloth taut, this way and that until the cloth is attached to the wall without wiinkles and with the squares in the cloth running vertically and horizontally not askew. When this has been done to your satisfaction, you are ready to cover up the somewhat unsightly edges with the molding The molding should be sanded down and then reated to a coating of linseed oil. After it is dry, tack the molding in place. This will cover up the edges of the cloth and dress up the "salon" considerably The linseed oil treatment will eventually cause the molding to turn a golden brown, which will give it a more pleasing appearance than some paint

After the "salon" is complete, you have an area of display space of a certain length and a certain depth Allowing generous spacing above and below as well as between pictures, decide on the hanging arrangement for your pictures, which should, of course, be anomited, preferably on 16- by 20 inch monishryon pictures hooks at the required places and hang your pictures.

An arrangement such as this is probably most suitable in the has-ment playroom, in the den, the attic, possibly the sprice gang—if any—which could very reasonably in turned into a sort of studio, if you felt is inclined. At any rate, it's an idea, and mayby one can add your own notions to bring the scheme nearer to the requirements of your win faithires.

KALART CONTEST

WINNERS

PeliZES totaling \$250 have been distribution to the Second Annual Kalart Synchro-Senlight Contest to winners in wrons parts of the country The first prize of \$100 went to G. A. Curit, Minnespolis, Minn.; the second of \$50 to Pranes H. Grawold, First Leutenant, A. C. Langley Field, Va.; and thard of \$55 to Forest J. Sorranon, Ames.

The first two winners are reproduced bown. The first two winners are reproduced

Announcing that the third annual contest will be inaugurated this summer, the Kalart Company officials comment on the second contest as follows:

"In analyzing synchro-sunlight picture-

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vo (16 on 120) Balda F3 5 Compur new	22 50
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good	22 50
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good	32 50
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tery good	18 50
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First prize-Synchro-Sunlight



Second prize-Synchro-Sunlight

for the second contest it was found that a great advance has been made in the quality of the pictures submitted. Photographers are beginning to learn how to use the synchronized flash in their daylight photography The majurity of photographs covered subjests and scenes related to the immediate family life Naturally, the most interesting subjects were those of habies, children, and pets. These synchro-sunlight photographs predominated in the contest and there were many fine examples

THE ZEISS ANNUAL SHOW

MORE pictures are telling stories without benefit of caption or title than ever before, according to the findings of the committee in charge of the Fifth Annual Zeiss Ikon Photographic Exhibition, which opened at the offices of Carl Zerss, Inc., in New York recently and is now on tour around the country. "It is apparent from a survey of this exhibition," say the committee, "that the present-day photographer, while retaining the qualities of spontancity and aliveness to human interest which characterized the old 'candid' shots with all their freshness, is now combining these qualities with pictorial and technical excellence. Portrasture is informal, but has the qualities that make for good painting or good graphic art of any type. It is also noteworthy that more pictures tell a story without a caption or title necessary Like a good cartoon, the essentials of the drama are all there within the confines of the picture.

"Several years ago," the committee con-tinues, "a survey of photographs such as this showed an interest in candid camera shots which rended to take the subject off guard.

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possibly in an embarrassing moment. The photographer was alive to the human interest and the photograph showed spontaneity. The trend then went definitely away from these so-called 'candid' shots toward the pictorial, stressing composition and pictorial excellence even in action shots. Cropping a photograph to bring out the pictorial values became an important part of the work." This year's exhibition differs from pre-

vious ones, in that it is limited to 300 prints, of which 200 are in an Invitation Section and 100 prints, as we have previously noted in this department, are the result of a nationwide contest.

The selected prints were picked from a total of more than 4000 entries, including photographs both from amateurs and professionals throughout the United States,

fessionals throughout the United States, Included in the Invitation Section are prints by Adolf Fasshender, F.R.P.S., M. U. Wallach, Helen Thompson Farrell, Margaret Bourke-White, Dever Timmons, A.R.P.S., T.R.P.S., Tolling Firesell, Nickolas Muray, Remac Lobse, Harold Harvey, Bob Leavitt, A.R.P.S., Onto John Caul. A.R.P.S. Vaccount of the Company of A R.P S. Otto John Gaul, A R P S., Vernon Whitman, Carl Mydans and Trunian D. Ven-

51 MOVIE CAMERAS

THE motion picture cameras being manufactured, sold, and used both in this country and abroad, now number 51, according to a survey just completed by Besbee Products Corporation, makers of amateur movie accessories These cameras include 8, 16 and 9.5-mm frame sizes, with electric and clockwork motor drives

ENLARGER HELMETS

NO need to stress the importance of keeping dust away from the enlarger, particularly the one employed to project miniature negatives. It is rather difficult, sometimes, to keep the enlarger as free of



Protection from dust

dust as we would like, so it is with something dust as we would have, so it as with sometimes of welcome relief that many workers have seen the advent of the so-called enlarger "helmet," a simple oil-skin pillow-case-like bag, with strings. The bag, or "helmet," is merely pulled over the enlarger and the strings drawn together and tied. One such

ROOKS ROOKS

r Amateur Photographers

New Ways in Photography, by Jacob Deschin, Emmently practical from every point of view, this new book contains nothing of theory and nothing that the advanced amateu photographer will not find valuable in one way or another. It comes the photographer will not find valuable in one way or another. It covers the whole range of amateur photography, discussing such things as trick pho-tography, photomurals, retouching, infra-red, and a number of other sub-divisions that will not be found elsewhere in as clear and concise a man-ner, \$2.90.

INFRA-RED PHOTOGRAPHY, by 5. O. Rawlings, A treatise on the use of photographic plates and films sensitive to infra-red. Exposure and processing are fully covered; formulas are given for sensitizing, \$105.

Universal Photo Almanac and Market Gude. How, when and what to photograph in order to make money with your camera; where to sell different types of prints, \$1.00.

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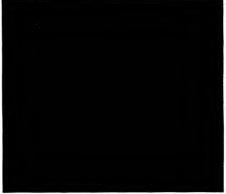


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The Pictures-of-the-Year are Made with Rollei Cameras

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Q. Is there a quick method of drying a roll of 6 by 6-em film so that enlargements may be made as soon as possible after washing of the negatives has been completed?—L. M.

A. A "warm-breeze" lan will do the track thang up the finds strip, remove surplus water carefully from both sides either with a vinces sponge or cotton, and allow the negatives to dry "normally" for several manutes. Then plug in your electric fan and direct the heat toward the film strip, taking the the least toward the film strip, taking the taken between film and in gatternate to that drying will be gradual and the heat will reach the strip fairly evenly

Q. Do photo chemicals, in general, deteriorate when kept dry and in the container? For example: I have a pound of carbonate I bought six months ago and it is only half gone. Is it likely to harm the quality of either negatives or prints when I use the last of it, say, six months from now? How about developing agents, such as metol and hydrechinon? An ounce lasts me a half year.—A. W.

A Provided you observe the precaution of keeping the chemicals absolutely dry, with secure covers and stoppers on cans or bottles, chemicals in the dry state will last long time Deterioration, through oxidation, begins really to set in seriously when the dry chemicals are converted into solution

Q. 1 am considering buying a German-make camera. My brother is and will be in Germany for some time and all he in Germany for some time and I have thought of sending him money so that he could get the camera there. Could you please telf me what duty I might have to pay if he keeps the camera near them have a set in our pulpement his own them. The country was the country of the c

A In either event, it would be necessary for him, when he brings the camera into this country, or for you, if it were shipped to you, to pay a duty of 20 percent on about half the American list price of the camera, or

the price paid for the camera abroad, whichever is the higher figure. Were a camera involved in which the lens had a higher value than the camera, a duty of 45 percent would be assessed in addition, it might be nece-sary to obtain special permission from the manufacturer's office in this country for the privilege of importing the camera. In general, it is not advisable for individuals to bring cameras into the country. The importer here cannot be expected to feel a responsibility for a camera he had no hand in importing and from which he gained no profit Therefore, should anything go wrong within the year covered by the guarantee the individual importer of a camera would have no redress from the importer or, as the term is loosely used, the "agent" in this country In addition, the camera purchased ahroad will have the Continental type of tripod bushing requiring the use of a bushing adapter to bring the size down to the American standard. And, of course, the focusing scale will be marked in meters,

O. 1 am enclosing a penell aketch showing the general outline of an enlarger which I am planning to build. I have an anastigmat lens //5.4 salvaged from an old camera, and it is this lens which I propose to use in the enlarger. I would appreciate it if you would briefly describe the essential features and requirements of the eularger.—P. G. H.

A. Answering your questions in the or-der indicated by the sketch, a 100-watt lamp of the opal enlarging type will provide a satisfactory light source; the lamp should be located opposite the center of the condensers and mounted on a movable rod to facilitate altering the distance between lamp and condensers. (Your sketch shows one condenser; to utilize the full value of the condenser type of illumination, two must be used) The illumination should, of course, be sufficient to cover the entire area of the size negative being enlarged. The condensers employed should be seven inches in diameter or a little larger than the diagonal of the 31/4 by 51/2-inch negative you are planning to enlarge. The condensers should be mounted convex side toward each other and flat side outward. The negative holder should be

located as closely as possible to the con-denser, and should be provided with a mask, with an opening just large enough to accommodate the negative being enlarged You do not mention the focal length of your lens so we cannot give an accurate reply to your question concerning the dis tance from the negative to the lens However, assuming your lens has a focal length of six inches and a two-times enlargement is the smallest you will require, the distance from negative to lens should be nine inches. If the focal length of your lens is slightly greater, allow for a greater extension, per aps as much as 1/2 to 1/1 of an inch For greater enlargements than two times, this negative-lens separation will be pro-portionately shortened as the enlarger helws is raised. For a six times enlargement, for example, this separation, under the circumstances, will be only 7 inches.

Q. 1 have a 12-inch 8-by-10 rapid rectilinear (f/8) lens. Am planning to remove one glass disk (cither front or back) to increase the focus to 24 inches, and attach to 2½ by 2½-inch camera. Kindly advise me what your opinion is on this subject. Would you rather recommend a telephoto lens, say about 7 or 8-inch focal length?—P. W. T.

A. While this is rather unorthodox procedure, there is no reason why you should not be able to use the big lens on the small camera. However, you understand, of course, that you will have to provide the lens with a tube so it will be separated by 24 inches from the film plane. Furthermore, since one element of the rapid rectilinear will admit only about one-fourth the illumination of the complete lens, your f value will be cut to //16 at full aperture You may, of course. retain the f/8 speed by using a 12-inch tube and employing the complete lens Concerning the purchase of a telephoto lens of 7 or 8-inch focal length, one of the principal advantages is the likelihood of greater lens speed. Chiefly, the question must be answered by your own needs or desires what type of work do you wish to do; what distances do you wish to work from; how much of the subject do you wish or need to include on your negative? Other questions will occur as you study the subject more thoroughly.

A. H. Rossitt Snyder has been putting out beckles on this subject for years and many anateurs over their camera pin-money successed directly to his advice. The book-lets may be seen in practically all photographic bookstores. Photo Markets', by John P. Lyons, and the "Universal Photo Almanac and Market Guide" contain extensive lists of possible markets for photographs. Among the helpful books on the subject are: 'Making Amateur Photography Pay', by E. J. Eackson, a practical news picture syndicate man; George W. Hesse's "Camera Journalism with the Miniature Camera"; and "Press Photography", by B. J. Suckson, a practical news Justice Sandard and "Press Photography", by B. J. Suckson, a practical news Justice Sandard and "Press Photography", by Justice X. Klatkd, a working press photography", by Justice X. Klatkd, a working press photography.

rapher. Answers to your several questions will be found fully discussed an these books. Generally speaking, for yournalistic purposes, 8 by Joinch gloosy prints are required, although 5 by 7-inch prints are also acceptable in most cases. Where to sell only prints or the negative itself is a matter for individual decision, of course. In some cases, where exclusiveness is desired, as by a picture syndrates, the sale of the negative profession of course by a higher price should be distanted where the negative procession of the profession of the prof

Q. A friend of mine recently advised me to purchase a panehromatic monotone viewing filter. He recommended the use of this before each exposure. Will you please tell me just what the good of this is, how it works, and the proper method of using?—F. A. C.

proper method of using Y—F. A. C.

A. The pandstromatic monotone viering filter, of which a number are now on the market, is employed to indicate to the eye approximately how a scene looks to the "black and while" argainet, that is, at is need to interpret color values in monotonia to the contraction of the contract

O. For some time I have been interested in preserving printed matter in the form of small negatives, a process commonly referred to as "microfilm." I would like to use a Retina 35-mm camera and some of the cheaper or film stocks. I have tried several films but in each case got grain which I consider too large for the best results, I would appreciate very much any information that you would be able to give me on this problem.—L. E. W.
A. A film now being generally employed for the purpose you have in mind is Agfa Reprolith. This is available in 35-mm perforated stock in minimum quantities of 100foot rolls. A special, extremely high contrast developing formula which must be used is nacked with the film

Q. I have in excellent condition my first camera, obtained in 1901, a 314 by 4½ No. 3 Folding Pocket Kodak. Could you tell me what f value corresponds to each of the three stops (three round holes in a metal silde)?—W.

A. M. A. Very likely the f values of these stops are f/11, f/16 and f/22. The best way to find out is to calculate the stops for yourself Learn the focal length of the leng by setting the lens at infinity and measuring the distance from the front of the lens to the plane of the film, Probably you will find this to be 51/4 inches or thereabouts. Now measure the diameter of the largest of the three round holes. Divide this into the focal length and the result is the f value of the particular round hole measured. If the hole measures 1/2 inch in diameter, the stop is approximately //11, the next smaller would then be f/16, and the smallest f/22.



Bear is the latest extendingly delitions to the popularline of Position, ST sum ministers it is remarkably like a substance of the property of the property of like a substance of the property of the property of a built in range finder—lens-synchronized and optically perfect operating on the epith-image principles All control parts are easily located and quirkly adbuted for taking pictures in rapid succession. Its built in tew minder is fully compensated for parsists and inparison devire locks the referen and All metal parts are chronium-lated. Case and bellows are of genuine leaster.

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The Dellina "O", equipped with Certar f/4 5 lens in Vario type shutter (speeds 1/25, 1/50, 1/100 sec, bulb and time), lists at only \$19.50 With Certar Anastigmat f/2 9 lens in Compur "B" shutter, only \$29.50

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GOOD as the reflecting telescope is, like was incapenave, its mange performance does not equal that of the refractor, though its images are more brilliantly illa manared and it is achromatic. Pondering the reasons for this, Nolbert J. Schell, 1019
Third Ave, Beaver Falls, Pa, believed the other control observed and in the control observed the control observed in the difficulty is eluminated by the Herschelant upper to reflection, but then



Figure 1. The off-side reflector

another one is introduced; assignation. A hint half bidden on page 613 of "ATMA" suggested to Schell the anover, tiling how the late Prof. W. H. Pickering experimented to kill off real effects of central obstructions in a reflector. Over the outer end of the tele stope be placed a disphragin having a hole less than half diameter and far off side, near the edge, so that the light that passed though it entirely secaped the diagonal and spider. Even though the mrore area was those were produced, the seeing at one; improved and the images appared like those given by refractors.

Scholl repeated this experiment and found Prof Prekering's words tine. The ngshot was the design and construction of the off-side telescope shown in Figure 1, in Figure 2, and in principle in Figure 3. At lits it looks about like any ordinary Newtonian reflector (except that it looks unusually trum) burfar from it! Study the upper part of Figure 3.

"The method decided upon," he writes,
"was to make a mirror of a certain diameter,
but give it a fagure the same as if i were
a section cut out of a larger mirror, and to
one side of the center. The image from such
a mirror would come to the same point as
it the imaginary large mirror were in use,
but it would be sufficiently to one side of
the section actually used to permit us to

view it direct, or else use a flat or even a secondary, without obstructing the path of light to the mirror."

light to the mirror.

To make the secretary or which would not be To make the secretary or to possible, "he states," be grand and polysh four mirror distributed amound a certer and blocked up with fillers, the whole samily lighter of as parabolical and then taken apart, but at would be doubtful if the difficulties would be pastified, considering the large size of the assembly. For this and the tension, the control of the according to the large size of the assembly. For this and the tension, to control as a newtrette, being the size of the second the second to the second the size of the second the s

"At this time," Schell continues, "I explained the scheme to Mr T G. Beede of Youngstown, Olno, who has had 45 years of experience in producing high gade surfaces and who has no equal, to my knowledge, in this class of work Mr. Beede hetame interested.

"As Figure 3 shows, the 10" interer is a second of an imaginary interes 25" in the anieter and 75" in becal length—long enough to use at primary focus, yet short enough to apply a fitture 2.1 secondary to give 15.1 final focus—that of the usual refractor, if this were desired.

"Train this point on the entire job is a great credit to the ability and patience of Mi Brede The figuring job is not one to be reconniended for beginners." [Av II A Lower comments, "It is easy to do on paper—but what a lot of aspirin one would need before he made one on glass! —Ed I

Well, Brede made the off ade or lopsided mirror, and the final result was, in 'Schell's words, 'star images that were small planet like disks, with ring systems autrounding them more nearly of the theoritral kind than he have ever seen in any reflector. Also increased detail on the North Ter's hands were pronounced—the to concentration of an estimated 90 percent of the light in the central disk."

The tube used is 13%" in diameter, with a small flat 5" inside focus, the image being brought out at right angles to the tube. The initio is tilted about ½".

Afterward it turned out that there was aiready an off-side interior at Mt. Wilson and two at the MeMati-Hulbert Observatory, Schell swears on "ATM" that he did not know any such mirror had ever been made, and, even if several had, Beede figured the peculiar mirror from seratch since he had no instructions not of his own gradual mak-

ing.

So far so good, but how did he do it?

For that is what the reader has no doubt heen saking as he read the above. This question we put up to Schell and he came through with all he and Beede had. Here

"While this is written by myself, Mr. Beede has concurred in the figuring description, he and I having gone over the matter the last time I was up to see him." [Youngs-

town 40 miles N W of Braver Falls, Beaver Falls 30 miles N W of Pittsburgh,—Ed.1

"The mirror was worked by hand, face up, on a fixed pedestal, throughout grinding, polishing and figuring No machine work or inchanneal controls whatever were used, although a mechanical control was tried first and discarded, as it was found unsatisfac

"After bringing the mirror to a triespherical surface, no further movement completely amount the pedestal in the ordinary way was possible. The mirror was always placed on the pedestal support in the idea treal position with relation to the axis linduring the figuring, and a inental picture of the condition of the surface guided the appleation of the figuring tools.

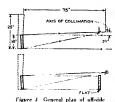
The figuring tools were pitch-coated in the usual manner. Their size was varied, but they were all sub-diameter tools, the dume-ters varying from ½ 10 ½ of mirror diameter, as needed. No advantage was found in the use of tools of shape other than round, and their edges were not trimmed to a rosette, or similar form

"Consultrable difficulty was encountered in getting a proper understanding of the surfax from the appearance mider test (Fig. uc. 3, bottom), and the effect of the application of the tools an correction. Mr. Bedelmond it a distinct advantage to use an elaboration of the kinfe edge, consisting of two kinfeediges in any each other in the form of a many-prependious failth by the Manchest of the surface of the s



Figure 2: The non-concentric mirror

"These mirrors, when placed in this position for terring, white spherical, show marked around the this, depending on the position of the kink-depending of the position of the kink-depending of the property of the property of the pretage into collimation. Likewise, when tested with eyepiece, while spherical, the returned pin-hole image (a slit would not be satisfactory here) shows a marked come, and as the figuring progresses, the come well shorten accordingly. If proper action is raking place in the figuring; otherwise the distagration of the image indicates improper polishing action. This type of test and the figuring to correct the surface is not unlike correcting large refractor objectives described many years ago by Alvan Clark where he stressed particularly the local correction necessary to round up such lenses, the local figuring being necessitated by differences in the refracting power of one portion of a piece of glass compared with another portion; and is quite apart from the zonal correction having to do with spherical aberration ordinarily associated with surface conditions or shape of a lens. While we do not have this



telescope, and set-up for testing

trouble in mirrors, we have similar work in figuring an off-axis mirror.

"The figuring was found to require strokes following the varying radii, as indicated by the distances from the theoretical axis, great care being necessary literally to coax the surface down without getting too deep. Also it was found that, since the reduction involves undercutting the sphere, it was best to continue this action until the extreme outer edge area (i.e., side away from the axis) blended with the remainder of the sur face In other words, it was better not to attempt a combination action of lengthening the radius of the outer zones and shortening the inner ones.

"As previously stated, extreme care v necessary in orientation of the mirror relative to the axis-line when placing on the testing stand, as this would present an altered aspect, making it difficult to determine the state of correction.

"The final criterion of correction was the mality of the pinhole image as received at the testing position after the three reflections taking place in the act-up.

"The above is the result of experience in working three of these mirrors. The first was finished after running up several blind alleys and getting back out of them again. I feel that an experienced mirror worker will follow this description, but no doubt if he tries it, will use his own methods and get there just the same. So much depends on the inthvidual, and his sense of touch and experience, in this hand work, that to lay down hard and fast rules is impossible. It is easier to do it than to tell how it is done. I think it was Ellison who once said that a man could read all the books on the subject and still might not have the ability to figure a good mirror."

Now that Schell and Beede have presented the working hints, who will undertake lop-sided mirrors? The surface is not an ordinary figure of revolution, and the work is irregular. Perhaps prudence is the better part of valor, if one is really a tyro.

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THE BEGINNER'S CORNER

TROM day to day readers who have made lelexcopes from he untractions in the host. "Amateur Telexcope Making," kindly send in to this department descriptions and photographs of them and, while lack of space prevents publication of more than a very few, they are all closely studied here under a reading glass, and all details noted. The one shown below struck this department as perhaps being one good solution of the beginner's problem of choosing a type of mounting for his first instrument it is simple to build, merapensive, efficient, portate, yet it, as next on the problem of the probl

Admittedly, this is not the telescope the average person has in mind to make, not claimage enough. To attain one's dream there are two ways. First, study the literature over and over, make numerous designs, evolve a complete one, build it. Second, study the literature, make a simple design like that below, build it, gen it on a few



Mrs. Watrous and Watrous telescope



Detail of the simple mounting

weeks or months, and then, in the light of a small experience (which inevitably brings to light immerous factors which no amount of mere study will reveal), design and make a telescape that will satisfy you. Those will choose the first course of fir a say later: "I don't think so well of this design of min as I thought I would, but I put too much work on it to distart it lightly now." For the preliminary electronic distances type

The axes are common pipe fittings. First a T with bong pin and pipe not its statched to the man leg of the triped through a hole film T, also the other T shown, is bord out miernally—about a 50 cent markine shop obtained to the two stab shafts. By an other arrangement, sometimes used, the axes turn out the threats already on the fit axes turn out the threats already on the fit are the stab of the st

The square tube of the telescope is made of straight ½" stock, wood, two at each corner, edge nailed (better screwed) and is very rigid Paint inside black. If near bright lights, enclose the lower 12" or so

Make main leg of tripod parallel the

Vary the details to suit your own taste Larger pape fittings are suggested, Di Watmus lumself mentions that the tele scope shakes a little too much in a breeze.

TELESCOPTICS ((ontinued from preceding page)

PEW anateurs attain the datmetion of having the results of their work pubbelied in quite so "toney" a purely scentic journal as The Astrophysical Journal, but Dr Otto Strave, Director of Yerkes Observatory and one of its editors, has called to the attention of your scribe in a letter "the recognition which the professional astronomers have given to Mr. H. A Lower "the recognition which the practicus plus tographs of the Milky Way. I am extremely tographs of the Milky Way. I am extremely the two Luwers, of Mr. Arkinu Pelayar, and of other pioneers in the construction and of the two Luwers, of Mr. Arkinu Pelayar, and of other pioneers in the construction and use of the Schmidt camers. These men have rendered a real service to satronomy and

have produced results of permanent value."
Ilarold Lower's textual contribution to
the journal named (January number) consists of but half a page of very compact
descriptive matter written in the scientist's
traditional objective style, but the photo-

graphic contribution it so concisely de scribes consists of six full-page photographs in Orion, Cepheus, and elsewhere, taken by his father, Charles A Lower, in red light with the Lower Schmidt. These are repriduced on fine paper. "I call to your attentiun," Dr Strave continues, "the conspicuous little nebula shown on one plate. This nebula is shown only on the red photograph and is absent on the photographs secured with violet light. An inspection of our stand-ard photographs of the Milky Way by Professor Ross, Professor Barnard, and others shows that the object can be barely suspected on some of the best violet exposures, but it seems to have escaped previous detec-tion and is not listed in the NGC or IC, I am mentioning this case only because I think it should serve as an additional stim-

ulus to our amateur astronomers."

Examination of the red-filter plate mentroned, and comparison with the no-filter plate of the same area, reveals a prominent object looking like a tuft of nebular matter on the one where there was nothing on the

other. And so it looks to this department, which, however, lays no claim to knowledge of astronomy (telescope making is mechanics, not astronomy), as though the Lowers had discovered at least some kind of world, even if it is not southern California real estate. Moreover, they have themselves been discovered by the astronomers.

In the same number of The Astrophysual Journal there is a 14-page article on the tests of the 82" mirror recently figured by C. A R. Lundin, formerly of Alvan Clark and Sons, now of Warner and Swasey, for the McDonald Observatory, its author being Dr. J. S. Plaskett, Director of the Dominion Observatory, Canada, Dr. Plaskett is an expert among astronomers in testing large murrors, having been called in by numerous institutions to test completed mirrors before their acceptance. The article shows in full detail how such mirrors are put over the tumps, too had that lack of space prevents reprinting it here, at least at present, Concluding his tests Dr. Plaskett states. "The quality of the mirror proved to be unequalled by any mirror previously made or made possible by the fact that the mirror's maximum departure from perfection was nowhere more than seven tenths of one millionth of an inch!

IN The Astrophysical Journal for Decem-ber, 1938, G. A. Mitchell of Pasadena has a five page illustrated article on "A Simplified Spectrohelioscope," describing the construction of a rotating-disk type of instrument. Readers of the Hale chapters on the spectrolichoscope in "ATM," will fully understand the significance. The design is such that all the mechanical work except one piece can be done with a breast drill, file, and a few taps. Mitchell is an amateur telescope maker whose vocation is the manufacture of the Mitchell Motion Picture (amera, standard camera in the Hollywood -tudine

MOST normally constituted scientists en-joy reading scientific fiction of the H. G. Wells type, provided it is original and really clever, Hearing that Harold A. Lower had contributed to the January number of Astounding Science-Fiction, your scribe visited the newsstand and picked up a copy to see how good the yarn would be. Deap-pointment! For the "yarn" turned out to be a straight descriptive article on stellar photography with Schmidts and other fast astronomical cameras, and at that, a pretty stiff, technical one-and not astounding.

N The Journal of the Royal Astronomical Society of Canada, H. Boyd Brydon, of Victoria, B. C., recently published four articles on the design of small observatories, giving many detailed drawings of several circular are now available for two bits, from the society named, at 198 College St. Toronto, Ont., Canada. Incidentally, Brydon lias also published an article on "Two Inexpensive Drives for Small Telescopes," in the January number of the same journal, this also being two bits.

THE Amateur Astronomical Association of Des Moines is the name of a new organization of which C. O. Davis, Des Moines, Iowa (no local address furnished), is the secretary.

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THE NOBLE PRIZES, by Fritz Henriksson, is a 60 page booklet which tells the inside story of these well known awards. It quotes Alfred Nabel's will and tells just how the Nobel Foundation is set up to carry forth the work of awarding prizes in broad fields of cudeavor. A list of prize winners is given and the book concludes with a compact his tornal survey of the Nobel family Illus trated American-Swedish News Exchange. Inc. 630 Fifth Avenue, New York (it) One dollar

PRACTICAL SPEEDS OF FILMS AND PLATES AND EXPOSURE METER MANUAL, by Joseph M. Bing, FRPS, goes a long way toward solving the exposure problem, which is un doubtedly the photographer's greatest stumbling block to success, It gives information on exposure meters and their use as well as a clear explanation of the various film speed rating systems. A supplement gives a complete listing of practically all film emplsions on the market, together with their speed ratings Photo Utilities, Inc. 10 West 33rd Street, New York Cars -25 cents

TRUBBLAT DIVILOPMENT AND ITS TARREST ON AIR THANSPORTATION by Edward Pearson Warner, is a James Jackson Calon Professorship lecture which is essentially a straightforward history of the progress that has been made in aircraft design from 1914 to date A carefully worked-out comparison of figures presents a statistical record of the rate and nature of the progress that has less up made toward the production of an amplane that will be able to give close competition in economic terms to surface transportation Norwich University, Northfield, Vermont -- in cents

SUMMER COOLING IN THE WARM AURILIAN ING-RESEARCH-RESIDENCE WITH COLD WA 1) R is a 92-page technical report of research undertaken to determine to what extent water from City water mains can be used in house cooling. Results appear to warrant further investigation. University of Illinois Engineering Experiment Station, Urbana, III - -90 cents.

HANDLE TOOL OF 1001 USES IS & 64-page, thoroughly illustrated booklet which dealwith various types of Handee power tooland their uses in the shop and home. Dozenof photographic illustrations supplement the text Chicago Wheel & Manufacturing Com-pany, 1101 West Monroe Street, Chicago, Illinois -Gratis.

ARC WILDING ELECTRODES AND ACCESSORIES is a 34 page catalogue that deals with procedures for producing all types of welds in mild steel, for welding all metals used to any extent industrially, and for applying surfacing metal to meet any type of wearaction in service. The details cover, among other things, recommended current range and arc voltages; arc length; polarity of welding current; and so on, Properties of welds produced in various metals are given and typical welding applications are illustrated, Request Bulletin 410-A. The Lincoln Electric Company, Cleveland, Ohio .-Cratic

SELECTING YOUR MINISTERN, CAMBRA FILM ts a 52-page booklet which describes in detail six different types of 35-mm film, Included is practical information on filin speeds, color sensitivity, grain sizes, and on Agla Ansco (orporation, Binghamton, New York . Gratis

A GUIDE FOR RETAIL ADVISING AND SELL-156 is an 88-page book which gives definitions, recommendations, standards, and so on, covering the advertising and sale of newelry, fabrics, furniture, radios, rugs, and many other commodities. It is of particular value to anyone who handles advertising. whether on the purchasing or the publica tion end National Better Business Bureau, Inc , 405 Lexington Avenue, New York City

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DELAYOUR MANUAL contains information and technical advice on the subject of color photography It is designed particularly for the advanced amateur and the professional photographer -Dujaye olor, Inc .10 Rocketeller Plaza, New York City,-25

THE G E SPIRANORE TRANSFORMER describes in complete detail the newly developed electric transformer which was the subject of a feature article appearing on page 157 of the March issue of Scientific American. The pamphlet is lavishly illustrated with drawings and photographs which tell the whole story. Request publication GES-2038. General Electric Company, Schenectady, New York -Gratis

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LEGAL HIGH-LIGHTS

Patent, Trade Mark, and Related Legal Proceedings That May Have a Direct Effect on Your Business

By ORSON D. MUNN, Litt.B., LL.B., Sc.D.

New York Bar
Editor, Scientific American

LIBERTY

TEETOTALERS to the contrary netwith standing, ginger ale and beer are goods of the same descriptive properties, according to a recent decision of the Court of Customs and Patent Appeals.

In the case in question a brown filed a potition to cancel the trade mark of a ganger ale manufacturer consisting of a representation of the Sistue of Liberty. The brower hald adopted and used on here, prior to any see by the ganger-ale manufacturer, a trade mark consisting of a representation of the Sistue of Liberty together with the word "Liberty". The Court found that the trade and that here and ganger ale were goods of the same described prior to the consistency of the theory and the consistency of the consistency and that here and ganger ale were goods of the same descriptive properties and accordnagly held that the trade mark of the ginger ale manufacturer should be cancelled

PADDY'S MARKET

PADDY'S Market was the colloquial name for an open-air market of peddlers and retail vendors doing business on one of the public streets in New York City With the mevitable march of progress the market was forced to move from one location to another and finally was not permitted to do business on the public streets. The peddlers and vendors had formed an association un der the name "Paddy's Market Produce Dealers and Merchants Association, Inc. and when the market was no longer permitted to do business on the public streets the Association rented premises near its former outdoor location and the Association in turn subleased space to its members Thereafter several individuals engaged in business under the name of "The Original Paddy's Market" and the Association filed suit against the individuals to restrain them from using the name on the grounds that it amounted to unfair competition. On motion of the Association, an injunction was granted against the individuals restraining them from using the name "The Original Paddy's Market.

PRIDE VS. MODESTY

PROUD though we may be, our natural undeaty place a certain restraint upon our announcement that once again Sernific American was one of the determining factors in a sait for patent infiringement and as a result was instrumental in saving the United States Government from paying profits or demages in a suit for patent in for patent in the patent in the profits or demages in a suit for patent in the patent

A suit for infringement of a patent re-

lating to actal hombing was brought in the Court of Claims against the United States Government. The patent in suit rilated to a method of dropping bombs wherehy the aircraft was pointed downwardly in a generally vertical direction and the bomb was dropped while the aircraft was in this position, threely reducing to a minimum the horizontal moment which is ordinarily imparted to a bomb by an aircraft flying in a horizontal direction. It will be applied factors must be taken into consideration, one of which is the velocity of the plans when the plane is flying in a substantially horizontal direction. It was controded in behalf of the pacinet chair he deluminated



"Fig. 7.—Making a dive toward the target. Leasting out wind-pressure. A would be the airman's point of clease to his the target while go also have a substantial to the target will go also, he preferred to none-dive to half-allitude, B would be his efective point for letting go his homb." Quoted from Scientific American Supplement, April 22, 1916

the factor of horizontal plane velocity, or

had, at least, reduced at to a minimum On hehalf of the government it was contended that the method of hombing described in the patent had been described and published many years prior to the date of high the application for the patent and in aupport of this contention a copy of the Scientific American Supplement of April 22, 1916 was introduced in cridence. The Serientific American Supplement contained an exhibit, amining other things, natted "If the valter dives (Fig. 7) towards his target, accuracy of aim becomes easier, and effective work can be done without selentific instru-

ments, but task from houtle fire become greater "Fig. 7 of the article referred to in the quotation is reproduced on this page to getler with the descriptive explanation thereof, which appeared in the Screntific American Supplement in 1916. It will be noted that this Sigure shows both the method of releasing bombs while a plane is flying in a horizontal direction and while a plane is dring downwardly.

In view of this article and other publications referred to by the Coort the invention described in the patent was held to be old and the patent was declared invalid.

IMPORTED PERFUMES

THE Circuit Court of Appeals for the Second Circuit recently rendered an opinion which will be far-reaching in regulating the practices of the perfume industry.

Perfume consists of a compound or concentrate inheling essential oils, flower essences, and animal matter or chemicals, which are bloaded together in varying proputions in accordance with the formula of strough perfumes. This perfume compound is a somewhat oils, heavy liquid which, while used oreasonally commercially, is not saleable to the public until it has been diluted with alcohol. When the perfume is applied to the public of the public of the perfume compound or concentrate in minute quantities.

It has been the custom of leading per dimers to imput the compound or concentrate into the United States and to dilute in with alcohol here. Perfumers adopted this practice because the concentrate or compound may be imported conoderably theaper and the savings in customs dutues are substantial. This product has been sold quite generally as an imported perfume or merely with the name of the perfumer and the words "Paris, France" or "Paris and New York."

The Federal Trade Commission has issued a number of complaints against leading perfumers charging that this practice constitutes mishranding under the Federal Trade Commission Act.

One importer appealed to the Creation Court of Appeals from an order of the Federal Trade Commission directing that it discontinue marketing perfume so prepared as imported perfume, I I was argued that the alcohol was merely a carrying agent and allutant and that it had no effect on the finished profuce, that the e-switzal portion of the perfume—namely, the perfume compound—was what the public was interested in, and since this was imported the perfume could properly he sold as an imported

The Court of Appeals held that the concentrated compound was not what the purchasing public normally understood as perfune, and that the addition of the alcohol (which constitutes from 80 to 95 percent of the finished product) was a manufacturing step necessary in order to sell the perfune to the public.

name to the pinne.

As a result of this decision it will be necessary for manufacturers who add alcishol or other dibuting agent in the United
States, to place a statement upon the containers in which the perfume is sold, to the
effect that the perfume concentrate or compound was diluted with alcohol in the
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ALBERT A. HOPKINS F. D. M. HIT. H. ALBERT G. INGALLS Y. P. PEK F. PROFESSOR HLMY, ADBRIS RUSSILL F. D. M. HIT. H. PROFESSOR ALEXANDER KLEWIN

CONTRIBUTING EDITORS

A b BICRANAN, Jr. Director of Research, Remington Arms Company. L WARRINGTON CRUIRB Director of Research Laboratories, Westinghouse Electric and Manu-lacturing Company. LACOB DESCRIN, Amateur Photography

CHI RCHILL EISENHART, Department of Mathematics, University of Wisconsin Statistician, Wisconsin Agricultural Station.

MIDHERS FISHBEIN, MD Editor of the Journal of the American Medical Association and of Hygeis. WILLIAM K GHEGORY, Professor of Verie brate Paleontology, Columbia University LEON A HAUSMAN, Professor of Zoology, New Jersey College for Women WALDEMAR KAEMPFFERT, New York Times

D. H KILLEFFER, Chemical Engineer IRVING LANGMUIR, Associate Director, Re-search Laboratory of the General Electric Point pany, Scheneciady M LUCKIESH, Director, Lighting Research Laboratory Incandescent Lamp Dept of Gan et al Electric Fompan), Nels Park, Cleveland D T MacDOUGAL, Associate in Plant Biology, Carnegle Institution of Washington, BOY W MINER, American Museum of Natural History

INTERELL W PORTER, Associate in Optics and Instrument Design, California Institute of

W D PULESTON, Captain, United States Navy J B RHINE Associate Professor of Psychology, linke University Chatrinani, Research Com-mittee, Boaton Society for Psychic Research, PHILIP H SMITH, Industrial Research

A WILKINS, Vice President and Director of Research, Revare Copper and Brass, Inc. W WOOD, Professor of Experimental Physics, Johns Houking University

VLADIMIR K ZWORYKIN, Director, Electron-les Research Laboratory, RCA Manufacturing Company, Victor Division

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The man across the table will laugh.

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The older man will sit quiet a moment and then in a tone of infinite pathos:

"I wish I had those ten years back," he will say

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And the other will answer.

"I wish I had those years back."

In which class are you putting yourself? The real difference between the two classes is this—one class of men hope vaguely to be independent tometime, the other class have convinced themselves

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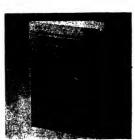
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and commy without." "Roock" or "your."

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Contest

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Ry Dale E. Mansperger and Carson W. Pepper

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mediately above It also tells how to make most attractive pieces such as lamps, candlesticks, coal tongs, and such practical things as soldering irons carpenters' bevel gages, and rea kettles all in metal. We would characterize this a "must' hook for all ampteur metal workers (95 pages, 712 by 10, well illustrated) - \$3.10 postpard - F. D. M.

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R. I D Let

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Books

SELECTED BY THE EDITORS



a commercial application of the former. The main part deals not superficially but at close grips with the law- governing the propagation of clastic waves in the carth's materials. the characteristics of instruments for recording earth vibrations and the important types of instruments (specific structural details omitted, however), the practical study of carthquakes with their cause and distribution, and the interpretation of scismograms The fundamentals of principles and procedures can be mastered by readers who have studied trigonometry, and the book will require study for most readers at isn't something that can be remped through, but is meaty and solid It is, however such a work as has not previously been available to the amateur seismologist, (430 pages, 5% by 8'1, 185 illustrations) \$6.10 postpaid 4 G I.

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OIL DOCTOR! MY FEET! By Dudley 1. Morton, M.D.

FOOT sufferers may throw away arch sup-ports, stop exercises, leave ugly special shoes in the closet's darkest corner and, by getting their feet X rayed and applying the fundamental science -- essentially simple engineering—so clearly set forth in this little book, learn the basics of the successful treat-ment of this orthopedist. He is an Associate Professor of Anatomy at the College of

Physicians and Surgeons, Columbia University, but your reviewer remembers him best as a scientific authority, widely recognized, on the evolution of the human foot. It would appear that even the average physician has given but little thought to feet, while the shoeman's approach is often super ficial (116 pages, 5 by 7½ inches, illustrated with X-ray photographs)-\$1.60, posipaid -161

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Ry Robert P. Walton

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of information on marilmana smoking- its history, distribution, present status in this country, its menace, also the plant source, technic of its use, with vivid or harid descriptions of the hashish experience, and acute and chronic effects; also its legitimate therapeutic applications, pharmaceutical and chemical considerations relating to the drug, clienical composition, and nomencla ture (233 pages, 6 by 9 melies, 17 illustra tions.)-\$3 10 postpaid.-4, G 1,

SCIENCE EXPERIENCES WITH INEXPENSIVE EQUIPMENT By Carleton John Lynde, Ph.D.

COMPANION book to that small vol A COMPANION BOOK to the same "Science Experiences With Home Equipment" which has enjoyed a very large sale. This one deals with physical principles that when practiced by the amateur in the home savor of magic to the observer. A few examples are. How to remove a bottle curk without touching it; Centrifugal force demonstrated with an egg beater; Lifting a bottle with a soda straw; Making bubbles that float and burn. Each of the 200 experiments is well illustrated with several clear drawings. (255 pages, 5¼ by 8.)—\$1.70 postpaid.—F. D. M.

OUR POINT OF VIEW

Modern Alchemy

ARE American research chumsis Masleep! Are their efforts pun comparson with the efforts of chemistaload! Are the self-sufficiency drives of some foreign autons—to desover laboratory-made products to supplant imports or ke out a diminishing nature supply—puting to shame the American denociate system of free enterprise.

Such questions have been asked often and as often answered-in the negative Dr. C. M. A. Stine, of the duPont Company, answered them again recently in a talk which emphatically stated that no nation anywhere, whatever its form of government, has surpassed this couniry either in the quantity or quality of the new materials of its industrial serence 'American chemical products now represent half the world's output We have established our self-sufficiency in dves and most drugs, we make mirates from the air and camphor from southern turpentine; and silk, bristles, and gut may some day cease to be imported products for we have a new synthetic, nylon, which can take the place of all three and can as well be made in sheets and solids. Several rubber substitutes are available to give vital aid in an enter-gency, and if we were faced with a shortage of wool, we could make a substitute from nulk from a formula alreads known Indeed, scanning the chemical field we find that practically everything announced-with the layman correpondent's usual awe-from Europe is already an accomplished fact in America but simply not commercialized because we are not economically hard up, or else is in the laboratory ready to emerge when needed

Dr. Stine's statement that "more than 200,000 compounds wholly new to man have emerged from the chemical laboratory in less than a quarter century, confirms this writer's contention that we have entered upon a synthetic chemical age. Moreover, it bids fair to surpass in spectacular accomplishment, in economic importance, and in social values any other comparable period through which man has passed. Already, gigantic industries have been built on some of the new chemicals-rayon, plastics, and now comes nylon-while a host of smaller ones have grown up around hundreds of lesser chemical developments. Other industries will certainly spring from the new prod-ucts now being worked out painstakingly by thousands of our most brilliant chemists. Their success is assured because their approach is right; they have ceased bohing upon wood, coal, metal, filters, and the like as war internals and have gone further backward to lawe elements. They now work primarly with carbon, oxygen, hydrogen, and nitiogen—from the air, water, soil, from coal and many forms of plant life. The superabundance of these elements promes, in our opinion, long life to the new Synthetic Chemistal Acci.—E. D. W.

Safety for Private Fliers

TRAGEDY stalked two young articles to a recently—and caught up with them in a fog over long Islaml, New York And the truly unfortunate part of the whole affair was that their deaths could have been avoided with facilities that are available but were not in use at the time. If it were compulsory that private phanes he equipped for two-way radio communication, it is quite likely that these two young men would still be alree.

The way it all lappened was their. Having rantof a plane for a weekend trip, the flores started from a point in Connectivit and headed for Long Island. The weather was good at the point of take off and flying was uneventful until fog was encountered over Long Island Cincling bower and lower in an effort to get their bearings on make a landing, a wing-tip strick a water tower and the plane dashed to the ground. While it is true that weather reports

could have been obtained it these nien had landed at one of the large airports ni Connecticut, such information was not available at their starting point. Without radio equipment they could not obtain reports en route, and thereby hes the point of our plea, Simple, lightweight, relatively inexpensive two-way radio equipment is available for aircraft use It enables the pilot at all times to keep in touch with ground stations, to know in advance what weather conditions are ahead of him and thus to be prepared for any emergency. Knowing, for example, that there is fog at the anport toward which he is heading, he can

iun back or land safely at a near by field. There is nothing new or untried about aircraft radio. It is in daily use by antransport lines. It has proved its value times without number. But there is no rule or regulation that makes its use on private planes compulsory, Here is a job that the Civil Aeronautics Auttority should take over immediately. With two-way radio equipment on private planes, especially those for hire, their pilots would have the same safety advantages as do those mea whose daily routine on

the art transport lines has jubed up such an enviable record of flights completed without accident. The radio weather reporting system is in operation. The private flier needs only to have the necessary equipment to make use of it. If he will not have it installed of his own free will, the CAA should see to it that he does for his own safety and for the good of aviation as a whole -4, P, P.

No Peace On Earth

E^{ARLY} in 1929, just a decade after the world's preoccupation with its War Number Que had relaxed sufficient ly to permit it to become for the first time aware of Professor Einstein and his theories, transatlantic cables announced that he had completed a new theory bringing under a single set of laws the phenomena of electricity and gravitation In the intervening ten years the preshad so surrounded him with an atmosphere of mystery and romance that people flocked to his Berlin apartment and Fran Einstein told reporters that he was being driven crazy by the attendant publicity He acquired a worried and nervous manner and a defensive exterior and pleaded that he hated publicity.

The above that it would not be the control of the c

In the meantime the great physicist hid behind the iron door of his attic retreat, with his piano and fiddle and small telescope, until the persecution waned.

A few years later another variety of persecution diver Professo Einstein to this country, where he thought persecution would end, yet he never has been quite able to escape it. While the dozen reporters who are themselves scientifical by backgrounded have behaved admirationally of the persecution
Now he has announced another try at the field theory and in doing so he has actually been forced to leave his home and hide from the hounds of undesired publicity. Our national nosiness drove Col. Lindbergh from his native land: Are we now to drive the great physicist away again or else crazy?—A. G. J.

50 Years Ago in . . .



(Condensed From Issues of May, 1889)

CANAL—"The most serious feature of the Nearagua canal project in a contracting and financial sense, is the great rock cut at the eastern divide, 3 miles long and averaging 120 feet deep by 80 ft wide on the hortom, containing in all some 7,000,000 enline yels, of naterial, or say 440 cube vide per hieral foot."

WATER—"One of the graudest engineering works of modern times, undertaken by the Corporation of Laverpool to supply that cuts and its submits with an abundance of the purest water from a equivatered valley high up among the momentains of North Wales, is now approaching its successful consummation. The stone of which the dam is built was taken from a quarry about a mile distant.

PRINTIN. "Inglish and Sortch manufacturers of machinery are beginning to had out that transventistation, their procedual prepidies to many things. American) there catalogues can best be illustrated on this side of the Atlante, and many times are now not only getting the engraving done in this country. but also the printing.

BOSTON —"The Boston Heads says that on third of Boston is now usering on spince stills, some 112 ft long, though in ordinary case a length of 30 feet is sufficient But in certain localities "and holesoctor which require piles of over 100 feet in length to reach limibottom."

BURLS—"Burls, used in making soncers with remarkable exciningities of grain, are excitesoness that grow upon various trees, such as the walnin, rosewood, malogiany, oak, and ash. They weigh from 1000 to 6000 pounds, and the largest and less count from Pet, and Office assess, and cost in the rough from \$50 in 400 earts a pound."

RABBITS—"It is stated that M. Pastent's plan of externmining rabbits by moculation with transmittable vious has proved to be a failing in Australia. The reward of 100 000 dollars offered by the N.S.W. government for an effective mode of destroying the rodents is as yet mix larmed."

TELEPHONES—"The Medical Press says there is talk of applying telephones to the infections wards of the French hospitals so us to enable the say height polaried in their contingions suffering to have the confort of harring their relatives voices without any risk of consymmentation by an interview."

MH.K—"It is said fresh milk may be preserved indefinitely by freezing it and maintaining it in the freezin state until wanted for use than, of the strainers now sailing on distant wayages are provided with steam refrigerators, in which milk and other foods may tend by increased for any lends of time."

EEFIL—"there are three systems of elevators to be used in the Fifel tower From the ground to what may be called the first store, where great restaurants will be established, there will be four elevators, two of the Oirs pattern and two of the systems of Rowa, Cambalauera, and I epape. From this story to the next one, aloust 300 feet from the ground, the Oirs elevators only are employed, in two of the legs of the tower. The top lift, a vertical distance of 393 levels, is made by Cavators on the Folium system, in which the carrage is worked by an enonmous poton. Those who go allow this distance to the lattern will have to thinh a parta starters."



north. The stone was too hard for pit's work, hammer and chied or hammer and sit, were, therefore, almost exclusively used. When hought to the dam by foromotive and wagons imming on a 3 foot gauge railway, they were lifted into position by seam canner and deposited on a bed of Denhad commat moster. The total length of this huge masoure dam across the month of the valley is \$172 feet, its greates thickness at the base is \$20 feet, it is greates thickness at the base is \$20 feet, it is greates thickness at the base is \$20 feet, it is greated for the foreign of the footnotion to the parapit of the carriage road on the top, is \$10 feet."

SPEAMER—"The first trip of the new passenger steamer Particular of the Fall Ricce Unit, from New York 10 Newport, via Long Tenton, of the Fall Ricce Was in More and April 21, with much success. She attained a speed of over 20 miles an hour with 61 pounds of steam. When her we include the New York of t

WAR SHIPS—'According to a careful estimate, the number of war sees to lained be key ray by the rawal powers of the would was 60, while more than 100 were building when it closed. England tol., with 15 sees belonging that 28 hundring than 128 hundring. Farne Launched 9 and laid down 15, Rosse, and ordered 2, and began 10, Germany just of Sweet-burntle burners, and the sees of the sees of the sees of the sees of the 10, and laid down 18. Japan ordered 3, and launched 3, the United States 4, method 16, and land down 6.

IRRICATION—"The Illussian government decided about a year ago to committee some stregation works near Mery lost the purpose of rendering the covern lands more smalled for the enhustage of cotton, and during the period slotch has since clapsed the first part of the scheme has been completed A dam—30 feet ligh—has been built across the river 'lurghals, in the Mery oesis, at a distance of fifty miles from the village of Sultanbund, and the wat quantities of water which are collected in this manner are being distributed to the sustreamling country by means of a network of lances and catals."

AND NOW FOR THE LUTURE

Cllow a Motor-Car Manufacturer is Applying Spectrographic Analysis to Mass Production

CAn Evaluation of the Relativity Theories, 20 Years After the First Direct Test by H P, Robertson, Ph.D.

(What the World Powers are Doing In then Grim Ruce of Armanients, by Dr. Osonr Parkes

(A New Type of Locomotive-Steam-Electric-Enters the High-Speed Rail Transportation Field.

CSulfapyridine Opens a New Era in Medleul History, by Barclay Moon Newman,

Personalities in Science

In recognition of outstanding achievenient in physical chemistry. Profesor Joel Henry Hiddebrand, of the University of California, has received the William H. Nichols Gold Medal of the New York Section of the American is the thirty-dirid chemist to receive the Nichols Medal, founded in 1902 "to simulate original research in chemistry" by the late Dr. William H. Nichols, chaitin member of the American Chemical Sucrety, and leader of the chemical industry in this country.

More than 400 secentists united in honoring Professor Hildebrand, who was cited for "his study of the solubility of non-electrolytes." The secentific accoupitshments of the mediable embase more than 30 years of research on liquid and solid coloring.

Trifessor Hildebrand is internationally known in the broad field of physical chinistry. More than that, he has been one of our few contemporary real teachers of chemistry. His pubble service has been of the highest order. His work in chemical warfare has contributed greatly to our national defence, both in the held and in the laboratory. His whole life has been one of service to science and the public weal.

In responding with his medal addresson "Order and Disorder in Pure Liquidand Solutions," Professor Hildebrand declared that "the shapes of moleculeshave important effects upon the properties of pure liquids and the solubility of one in another.

"The molecules of mercury, for example," he explained, "are spherical, those of parafin are shaped somewhat like sausages, those of benzene are flat hexagons, while water molecules are right-angled.

"Liquids and concentrated solutions have been much harder to deal with than gases or solids. Some of the earlier theories pictured liquids as analogous to gases, others as quasi-solids. Recently, however, the efforts of a number of competent investigators are combining to develop a general theory of the liquid statemore in accord with the actual properties of liquids and solutions.

"Light recently thrown on the structure of liquids has been largely responsible for this progress. The scattering of X rays has been a most powerful meanof revealing structure, not only of solids, where a large body of knowledge has a



JOEL H. HILDEBRAND

ready been accumulated, but also of hquids In the case of solids, a lattice structure is revealed, but with liquids the structure is best expressed by a so-called distribution function, a wavelike curve which expresses the frequency at which molecules are found at different distances from any one molecule arbitrarily chosen as center of reference.

"An artificial model has been con structed, which corresponds closely with the structure of mercury as revealed by X rays. The model consists of gelatin balls suspended in a solution of gelatin, which has been boiled to destroy its lower to set."

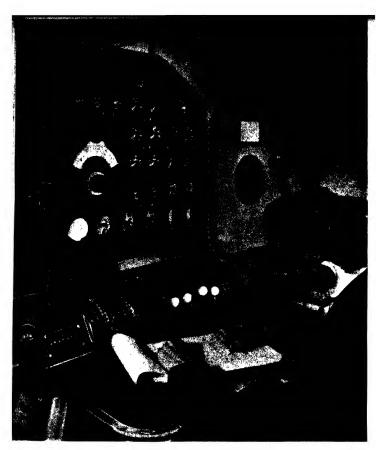
power to set."

During the World War, Professor
Hildebrand was first commissioned captain of the Ordanace Reserve Corps, then
major and later lisentant-colonel in the
Chemical Warfare Service. As director of
the Chemical Warfare Service laboratory
at Puteaux, near Paris, and as commanding officer of Hanhon Field, near Chaimont, he played an inportant rôle in

organizing the American Expeditionary Force Cas Defense School and the experimental field for gas warfare research under practical conditions, for which he received the Distinguished Service Modal.

He suggested to the United States Bareau of Mines the use of a nuxture of behum and oxygen in place of air for divers and caisson workers to recent the dangerous causes un desease or "bends." The effectiveness of this artificial atmosphere was recently demonstrated by Max Noll, engineer, with the collaboration of Dr. Edgar End, physiologist of Marquette University, in increasing the record for deep daving by 100 few daying by 100 few ord for deep daving by 100 few ord few

Professor Hildebrand is a member of the National Academy of Sciences, a past president of the American Physical Society, and a fellow of the American Association for the Advancement of Science. He is president of the Sierra Chib and in 1936 managed the United States Olympic Ski Team



NERVE CENTER
OF THE "YANKEE CLIPPER"

ARGEST aircraft in the world, the Yunāre Chppert.

I designed for transoceanic passenger service, is the first of a fleet of six being built by Boeing. The ship is an all-metal, double-deck flying-boat powered by four 1500-horsepower Cyclone engines. She will accommodate 74 day passengers or 40 passengers in berths. All engines are accessible for servicing or repair during flight. In the photograph is shown the Engineering Officer at his post where are grouped the instruments and controls for the power-plants. From this point he can communicate by telephone with any of the Flight Officers at their respective stations.



the flying laboratory of linted Air Lines Here is carried on research work that, conducted under actual conditions of light, yields results which will directly affect future airline policies

How Safe Is Air Travel?

THE question, "How Safe is Flying?" is in the utinds of 90 percent of the people today who do not travel by air, fear of flying is the reason given by all but 10 percent of non filers when they are asked why they do not travel by air,

This fear is wholly out of proportion to the actual risk involved in modern an transportation.

It is predicated on ignorance of the tabid advancement in air-transport operations. It is exaggerated by imaginary conceptions of the inherent and natural obstacles to flying in the form of air pockets. gravated by dramatization of airplane accidents airline, private flying, military, and otherwise- which over-emphasizes the extent of airline accidents, It is being gradually eliminated by educating the public and familiarizing them with the facts of the case. Complete public acceptance of air travel will come sooner. perhaps, than is expected, because of the speeding up of visualization facilities for the exchange of thoughts and ideas, and because aircraft manufacturers and accessory producers are going persistently about the job of taking every "if" out of air travel.

In 1938, the airline accidents claimed 25 passenger lives in air-transport planes in regular scheduled operation and flew 22,445,019 miles per fatality, a mileageper-fatality increase of 88 percent over Rapid Advance in Air-Transport Operations Has Been Made Possible by Applied Research That Aims To Take Every "If" Out of Air Travel

By R. E. JOHNSON

1937 when 40 passengers were killed during a year that scheduled planes flew 11,915,079 passenger-miles per fatality Six times as many people were nurdered in Chicago during 1938 as were killed in all of the domestic air-transport accidents during the same year.

until partitions yeard as one that stands up well under close sentiny and attestthe success of engineering concentration in those factors which in the past lawcontributed to ait line troubles. In barely, and the contributed to ait line troubles. In barely, we calculate the past lawcontributed to ait line troubles. In barely, and the contributed the past lawcontributed to ait line troubles. In barely, and the past lawtyper service in the United States—
- the air lines have incorably eliminated to obtatele after obstacle in the pathway of
the highest possible rate of operating demendability.

M ECHANICAL failure was a frequent factor in flying ten years ago. This covered a multitude of troubles, the principal one of which can be considered as engine failure. In the early days of single-engined operation, engine failure was a fairly common occurrence and it meant at least a forced landing on the spot. Another curse of early day accidents was getting lost, which paved the way for such a accident-cassing situations as getting off the airway and getting into tertain considerably higher than that on the route, running out of fuel, and so one

The problem of radio static, which may cause the pilot to get lost by interfering with his use of radio navigating and communication facilities, has figured prominently in certain accidents, Weather likewise has long been a trouble-maker for an lines—see, fog, inexpected high-veloc

its winds at upper elevations and so on. These, then, have been the principal causes of acculents, engine and other mechanical failures, failure of the hir aim element, and weather But many things have been done about these conditions in the last few years both in the development of facilities specifically in tended to eliminate accident causes and in policies and practices designed to neutralize the human element as the unportant factor which it has been in the past. Consider mechanical failure, for



A laboratory set-up for creating man-made static for use in testing aircraft rodio equipment

example Modern aircraft engines are truly standards of precision and mechanical efficiency. Instead of engine failure being frequent, or even occasional, it is very infrequently experienced in modern airline operation Furthermore, there are two engines on modern transport planes, each capable not only of sustaining flight, but also of enabling the airplane to climb as high as two miles above sea level. Thus, in the event of the failure of one engine, the modern an liner, unlike the plane of 1928, can continue with adequate power produced by the other engine. In every other respect there has been mechanical refinement and application of precision workmanship to the point where the modern airplane is an extraordinarily efficient piece of equipment constantly maintained in that condition by the operating machine,

THE questions of weather and human element more ries go hand in land it is the recognition of weather conditions and the use of judgment in dealing with those conditions rather than the presence of the conditions themselves, that determine the effect of weather on airline operation For example; Today's airplanes are equipped with efficient desing equipment in the form of boots along the leading edges of wing and tail surfaces, as well as spinners and final descring protection for the propellers lowever, under extremely severe ising conditions, airplanes with this protection can still get into trouble

Modern arluns diagnose weather conditions to deric must the presence and degree of seing conditions. If they are sever, flights are dispatched around the conditions when that is possible, otherwise they are cancelled Science will excutually bring to the airplane complete protection against any and all reing conditions but, in the meantine, arthese are exercising conservative discretion; in the new of the facilities now available. This is the underlying principle of all transport policies and practices and to a great expolicies and practices and to a great extent explains the high safety record attained by domestic arrines last year. The recognition of the margins which are allowable on various equipment under various conditions, and the constant adherence to the conservative side of those margins, spell the success that is now attending the advancement of United States arrine operations.

Under certain weather conditions, static interference is so had as completely to put out of commission all radio contact with the ground, either by voice or by directive radio-range signals. Vers ago, United Air Lines established

a project to attack this problem of static and uncovered information that paved the way for a solution that is as simple as it is effective After extensive research and experimentation in laboratorics, both on the ground and in the air, a simple trailing wire device for the cradication of static was developed and installed at the close of 1938 on all United planes and made available for installation on other airlines. By pressing a button which releases the wire from the tail of the airplane the pilot can climinate the noises that range from sounds simulating bacon fixing over a hot fire to the crashing of cymbak

The importance of this development to the safety of air transportation may be better appreciated by realizing that certain accidents have been caused directly and indirectly by lack of sub-protection against static. Now this simple length of wire, with one end attached to the metal tail of the airliner and the other to a paper drinking cup, which parachites the wire out into the slip stream and holds it extended, sends this

once paralyzing static streaming off harmlessly into space, keeping always clear the precious code radio-range vignals and two-way voice messages between the plane and ground stations.

Check and double check and even triple check is the by-word of airline engineers in their offensive against acci dents. Trouble was caused in the past when an airplane, flying in the clouds on instruments and losing its radio reception because of static, drifted off its course and flew into terrain substantially higher than that on the airway itself. Several problems of facilities and policies were involved in cases of that kind. One of them, of course, was the elimination of static, which has been accomplished, Another was the development of a device which would tell the pilot how high he was above the ground and warn luni should be approach terrain as high as his flight altitude

THE authodox altimaters, of course, record elevation in terms of sea level. When a pilot is on course and knows his position, he can easily calculate his deviation above the ground by compensating his elevation above sea level with the known altitude of the terrain even which he is Bying. But if he is not sure of his exact location he cannot determine even acity the height of his flight level above the ground.

For more than two years United worked with Western Electric and the Bell Laboratoris to develop the answer to this problem Recently, in a series of exhaustive tests and demonstrations, the susseer was made public in the form of a terrain clearance indicator, which in reality is a radio altimeter recording the plane's elevation in terms of feet above the terrain.

Still another way to solve the problem is to establish prescribed flight altitudes below which pilots are not allowed to



Checking depth perception of an airline pilot's eyes

fly. These altitudes, varying on divisions according to height of the terrain along the routes, are for instrument flying-at least a half a mile above terrain at all times-and are adequate to clear the highest points for some distance on either side of the route As a check on the maintenance of these abitudes, the airline posintains an automatic recording barograph in the tail of each airplane. This device constantly charts the elevation of the plane's flight and is checked by the dispatcher at the end of each flight to make sure that minimum altitudes are being maintained. Penalties for deviation from these minimum altitudes, without express permission under conditions which would make for increased safety are as severe as possible.

COMMERCIAL application of instrument landings is practically in effect, with the completion of installation of landing system apparatus at eight anports in the United States and the plans of authres soon to install necessary reciving cumponent in transport planes.

In August, 1937, a sense of mistrument landing demonstrations were made at Oakland Municipal Aurport before commercial airlines, Government civil an authorities, and military aviation officials. These demonstrations enhantated free years of intensive work and navel



Equipment in the nose compartment of the airplane shown on page 279

the way for the successful completion of the instrument landing method.

A hasic instrument-landing system had been insalled in Oakland by the Department of Commerce in 1933 and turned over to United for any use it might make of the existing equipment. Pilot R. T. Freng, now director of flying for the company, did the majur share of the actual flying during the experimental program and, in 1934-1935, with the co-operation of J. R. Cunningham, Director Communications, developed the use

of the automatic pilot in instrument landings. Their work simplified the problem and paved the way for a ready acceptance of this important aid to all safety. Freig made approximately 475 landings on the instrument landing system during the development period

Because judgment is so important in air transportation, the animes have been developing their personnel to increase the effectiveness of the judgment exercised. For example, one an line, through its own school of aeronautics, provides a thorough and complete system of home study training to all employes at no cost Its employes thus are educated in the latest safety aids and princtices, Practical comses covering every phase of airline operation-meteorology, power plants, mechanics, navigation, air lawbave been developed by the faculty of the school and department heads of the dir hou

These courses are made available to all comployes, who may take any or all of those included in the curriculum Certain courses are required. For example, all thing to sainth have here studying neteorology and advanced meteorology in the past three years. In many cases the courses are conducted in seminars, and, in any case, the student's work is thoroughly checked and a written report on each lesson is given by the faulty.

The purpose of the extensive homestudy program is both to improve the employe's ability and efficiency in his particular work and to develop him and prepare him for advancement. The net effect is considerably increased efficiency in employees.

Still another move being made by the arthurs on the scientifically laid out program of are deart climination is in the medical direction. Every aithie mainstains health checking service for its flight personnel, but Colonel A. D. Tuttle, M.D., formerly Commandant of the Amry's School of Aviation Medicine and now company medical director for an aithine, has gone further and has just completed the world's first continuing medical study of the physiological effect of fruing on passengers.

Representing an examination of the records of 261,370 passengers carried on one arrline's planes during the past year, the study showed that only 0.59 percent of passengers "suffered discomfort of any kind, including nervousness," Colonel Tuttle stated

Only three passengers in a thousand were troubled with air sickness, a rate not only much lower than that applying to sea-sickness, but one comparing favorably with land surface transportation, according to comparisons made by Colonel Tuttle with National Safety Council satistics.

Aside from air-sickness, one interesting feature of the study was the fact that there were cases of car trouble reported m only 0.05 percent of all pessengers earried during the entire period. Despite the occasional evidence of the effect of altitude changes on the cars of passengers during sevents and descents, the survey revealed that only 1440 out of 261,370 passengers underwent ear discomfort. This can be attributed to the company policy of restricting descents to a rate not to exceed 300 feet per minute and climbs to not more than 400 feet per minute. Thus the guadual change of pressure is



Hearing of an pilots is regularly tested by means of an audiometer

not too great for compensation in the car passages

Although numerous estimates have been made in the past as to the prevalence of air-sickness, car trouble, and other discomforts, this is the first authoritative study to be made on the subject to determine the real facts in the light of modein an transportation

ngs or noteers at an emporation. It is heliced that, if he commung is not better that the commung is not the commung is not the commung is not the community of
In those days applanes flew at relatively low levels. Flight altitudes of 1000 to 2000 feet above the terrain were average and in the case of schedules operating in the face of appreciable headwinds, even lower cruising elevations were maintained. This alone aggravated susceptibility to air sickness as those flight conditions much too frequently encountered rough air. In contrast, today's operations average from 4000 to 6000 feet, and even more, above the ground; generally speaking, at those flight altitudes smooth air is the rule rather than the exception. Almost invariably the air is smoother at high altitudes than at low altitudes.

Animals Bring Us Diseases

ANIMALS are earriers of certain disacess which can be transmitted to man despite the zoological gap between him and the annuals in hismediate environment Several such diseases entered the news recently. Typical for example, broke out in Poland almoin Jewish exiles from Gernanny, Tularema, or rabbit fever, cass schowed a sharp increase in the United States in 1938, Rocky Mountain spotted fever, having jounneyed across the nation to the east, entrenched ut-elf more fruity in the Pets, Domesticated and Wild Animals Carry Bacilli Deadly for Humans . . . Are Hosts to Parasites Causing Serious Human Ailments, Death

By WILLIAM WOLF

Animals provide food for man, they serve as heasts of burden, they furnish fur and wool for clothing. Man lives intimately with some as pets and he toler-

ates the existence of rodents. The piece paid for this proximity and employment of animals sometimes is illness and death. It is a needless payment, too; for, with a few exceptions, every one of these diseases could be controlled or eradicated.

Trichinosis, the most important of these diseases at present, is caused by a small nematode worm, the Trichinella spiralis, which is found in the field of swine, and some other animals

Man takes in the trelining through eating piek produits, and in the human hody they enter the digestive tract, the journalistic, systeme, and pulmonary in cutations, the brain, the heart miscless and the shated, skeletal, and other miscless as circulating larvae, matured adults, or as degenerate larvae which become encysted—and eventually calefied— —in miscular tissue.

Iltere is a health menace of major proportions, for their ex no reason to doubt Public Health Service investigators' conclusions that 12.5 percent of the country's population is affected. Indeed, that percentage may be diagnowed as almost anything, some 50 disease conditionaing been listed as having been confused with trichmosis. The number of trechinae in human beings depends entirely upon the number ingested, for they do not multiply in the body of man.

PIGS become carriers of trichinae in various ways, but the most important is through the consumption of garbage containing scraps of raw or partly cooked pork infested with trichinae This accounts for the fact that the high est averages of trichinosis are reported from Boston (27.6 percent of the population) and San Francisco (24 percent), since both the eastern and western seaboards have large garbage-feeding establishments supplying pork. In the south, hogs run wild and forage for acorns, grain, and vegetable feed with the result that the southern states have the least number of cases. Where hogs are grain-fed in the midwest, there is little trichinosis.

In recent studies on trichinosis, Maurice C. Hall and Benjamin Collins, of the U.S. Public Health Service, emphasized the fact that pork is a wholesome, desirable meat, and that the widespread prevalence of trichinosis is not a reason for not eating nock.

a reason for not eating pork, but an excellent reason for cooking it well. Thirty minutes to the pound fur large, thick cuts is an approximate cooking guide.



Making a culture of anthrax in the laboratory using infected goat hide with other pieces of hide in the search for a distinct and Below: A clipping from a New York newspaper

Middle Atlante states and caused a number of fatalities more alarming was an epidemic of bubonic plague among indents in the far west, for this dieaded pestilence of the past is carried to man by lates from fleas which desert infected rats and squirrels.

These, plus endemic outbreaks of rabies, held the public's interest; but other diseases carried by animals and acquired by man are far more common and cause greater health and economic concern It is estimated, for example that 16.000,000 persons in this country are infected with trichinosis alone. This means that one out of every eight is a victim of this disease caused by a parasite found in pork-a staggering average which gives the United States the highest incidence among all nations. Bovine tuberculosis and undulant fever are among the other important animal conveyed diseases, while the lesser ones pose their own health problems.



Unlike trichinosis, bovine tuberculosis, another disease contracted from animals, has been studied and well under control for many years.

The consumption of raw milk from infected cows pureds that descare to human beings. However, county by county, area by area, and state by state, tubercular cattle have been eliminated from berds until today the precentage of reactors to the tuberculin test, devised by Robert Koch in 1890 and later improved, is only 0.7 percent, whereas in 1917 it was 3.2.

Chronic bracellosis, or undulant few, another human disease due to the use of raw, or unpasteurized, milk, is increasing, however. By the eard of August 1938, there were 2000 reported cases in this country, twice as many as in all of 1937, indicating a peak year. The first reported epidenic here occurred at Phoenix, Arrivan, in 1922.

Medical interest in undulant fewer dates back to the Crimean War when thousands of British soldiers in the Medicerianean basin were stricken with Malice fewer, a variant caused by goat's milk in 1886, the germ was discovered; in 1897, the germ causing contagious shortion in cattle was isolated, and in 1918, suctroplogist. Alter C. Exans, of the U.S. Public Health Service, announced that the two were closely related, later proving that the human disease originates in cattle, goats, and swarp

The disease often is merrectly diagmosel because its milder form resembleinfluenza and the more severe attacks are smillar to tuberculosis, rheimatism, typhod, and malaria. It receives its name of indulant fewer from the distinguishing ital fewer which advances in the atternom, reaches a peak from two fee. PM, and then recedes in the evening. Fatalities fortunately are raise, but the disease leaves the heart weakened

TWO tapeworms hetter illustrate the close and long-continued relationship between man and domestic food animals than any of the preceding discusses, for their immature or larval stages are lived in animals and their adult stage only in man. Human beings, in other words, are essential to their life typle. They are the pork tapeworm, Teania solium, and the beef tapeworm, Teania solium, and the beef tapeworm. Teania solium, and the beef tapeworm the small intestine of man when released by the digestion of raw or slightly-cooked meat.

In 1934, some 300 inhabitants of Sackville, a woolen-working fown near Philadelphia, packed up and deserted their homes in a dramatic mass exodus because the 134-year-old village was threatened with a major outbreak of antrax. Antrax is an infectious disease attacking the skin, respiratory, or digestive systems. It is caused by a specific micro-organism, the anthrax hacillus,



The first line of defense against the importation into this country of hubonic plague and typhus fever: ship-fumigating squad at a U.S. Quarantine Station

and is common to cattle, horses, sheep, goats, and wild herbivorous animals,

The exhindreal bacilli, on heing released from an animal's body, produce, on contact with air, elliptical sportshighly resistant to heat, cold, drying, and disinferants. In the Sackille case, the anthiax spores were in the soil and in the old houses, and the bacilli and spores were in the factories where the mon worked.

Man acquires the disease through handling wool-hence the name "woolcarders' disease"—from hides in leather-working establishments, from infected careases, or from the soil. Pennsylvania, a tannery center, gets from 15 to 20 authrax cases annually. A fourth of these human vertins der

Glanders can be contracted by man from horses and mules, but is of lattle importance medically llorses, however, are responsible for an entirely new discase, encephalomyelitis, a brain infection which killed a dozen children in New England recently. It is carried from houses to human victims by the bates of mosquittees.

The cry of "mad dog" still rouses terror in human being, for rabies is a 100 percent fatal disease if contracted, although the Pasteur treatment, in general use for several decades, is 100 percent effective if employed in time. Thus nation, strangely enough, tolerates rabies. According to John R. Mohler, of the Bureau of Animal Industry, "there is no communicable disease which is more easily prevented and eradicated than rabies."

Rabies is conveyed to man, of course, principally through the bites of infected dogs or through saliva from a rabid dog entering a break in the skin. Five years ago a three-months-old puppy became a pet in a California C.C.C. camp and developed rabies. Seventy-two persons, including 62 C.C.C. men, four U.S. rangers, and six civilians were bitten, licked, or otherwise exposed, and all 72 took the Pasteir prophylaxis.

There are two types of rabies in dogs: the furious, volent, or irritable, and the dumb, or paralytic, type. Furious rabies are of greater concern to human heings, for the volent dog will roam, fight, and bite. Cattle bitten by rabid dogs develop both types. Cats usually contract paralytic values.

The Pasteur treatment has no curative value and is useless after rables develops, which, mercifully, isn't until approximately a month after exposure, blowing time for the treatments. Usually 14 injections are given, but in face or neck wounds a series of 21 or even 28 will be administered, Bites about the head are particularly dangerons because of their proximity to the brain and spinual coid.

NOT all bites from tabel animals cause rabses in man. The tirus extransmitted in about 30 percent of cases; but all persons exposed should be given the prohyblaxis. There are occasional curious cases of lysophobia, or peudo-tables, in which the imagination creates all the symptoms of hydrophomesexpert that the "victims" recover.

The cost of rabies to this country is not reckoned so much in the number of deaths—about 100 a year—as in suffering and naisely. And it is so easily eliminated, Denmark, Sweden, and Norway have practically eliminated it by requiring that all dogs at large should be muzled. Great Britain was free of rables for 16 years until 1918 through strict quarantines; then the disease en-



Photographic Couries Army Medical Museum Lungs and windpipe of a rabbit killed by tularemia. Diseased parts are grayish spots with darker centers. At right: Primary wher from handling tularemia-infected rabbit

tered the country again and was not checked until 1922. Since then there have been no further cases.

Man's pets are responsible for other human diseases, and the dog is guilty a second time in the case of the eastern type of Rocky Mountain spotted fever, for canine carriers spread the American dog tick which is the vector of this disease. An average of 140 cases are reported annually in the eastern and southern states, an incidence which seems to be increasing. The human mortality rate is about 25 percent-high enough to put spotted fever in the deadly disease class The western Rocky Mountain spotted fever, caused by the wood tick, Dermacentor andersons, which is common to many rodents, is even more virulent, 75 percent of the cases in central western Montana concluding fatally. The American dog tick, Dermacentor variabilis, spreads westward along northern boundary states, overlapping the doniain of andersoni

Both ticks are blood-suckers, feeding on human beings at the hairy back of the head or the armpits and, if infected, spread the disease to their human hosts.

spread the disease to their human hosts. The same ticks may carry thilaremia, tick paralysis, and Colorado tick fever, a mild infection without the skin cruptions which characterize Rocky Mountain spotted fever.

Postucoss, or pariot fever, deserves some mention under the discasse caused by pets. It is borne by the politacine birds such as pariots, parradeets, Amazons, Mexican doubleheads, cockatons, macaws, and lowerbirds and is caused by a mysterious virus about which the present knowledge convists largely of the fact that it is filterable, as demonstrated in 1930. A major outhreak occurred in

1929-30; another in 1932 caused restrictions to be placed upon the importation of carrier brids. In adults over 30, the disease was 24 percent fatal.

desses was 24 per early sleeping. The world-shaking great plagues of the past are not dead—only sleeping. In the 14th Century, destroying one fourth of the post are not dead to the "Great Plague" of Lundon which killed 70,000 in 1665, are no farther removed from us than the states of California, Nevada, Montana, Idaho, Oregon, Washington,



and Utah, Not that many human beings are affected in those states, but rats and squirrels are victims and the deseave is spread to man by fleas which desert plegue-killed rodent hosts. There were five human cases early in 1938, enough to make the U.S. Public Health Service increase its efforts toward externinaing rats and ground squirrels in the area. Health officials were not caught unprepared, for they had warning in 1924 when the plague struck 24 persons in Los Augeles.

There are two types, the bubonic plague, transmitted by fleas, and the deadly pneumone plague which can be carried by the breath of stricken humans. In the latter, there is a high fever, constant coughing, and usually fatal termination in three or four days.

Typhus, a highly contagious fever, is another plague borne by fleas and lice from rats, At present it is an ever-present menace to world health, for a typhus outbreak followed the cholera epidemic in China's war zones in 1938; and, in Spain, refugee camps swarming with women, children, and vernin create ideal conditions for an epidemic that could easily become pandemic. The means of prevention are at hand here, however. In 1932, Dr. Dolla E. Dyer, U.S. Public Health Service, developed a vaccine for the flea-borne type and then Dr. Hans Zinsser, of Harvard, prepared a vaccine for louse borne typhus.

Some idea of what typhus means to the human race can be gained from past epidemics. In 1914, the disease killed 150,000 Serbians and 30,000 of their Austrian prisoners of war. From Serbia, it spread to Russia where it attacked the amazing total of 25,000,000 persons, killing 3,000,000. It was kept out of the United States by de-lousing American shddiers before demobilization.

Soldiers before encommission of cocasional cases of rat-bite fever and infectious jaundice. Man acquires the late through eating, touching, or drinking food contaminated by contact with infected rats.

Thurakeama, or rabbit fever, is the last of the important rodent-earlied diseases and has caused recent consternation among health ofherals because of a sharp increase in cases, Illinois waparticularly hard bit last fall with 10 deaths in less than a mouth and 243 stricken, but other widely-scattered states had fatalities. The Moldle Atlantic states reported a number of deaths. East St. Ionis, Illinois, barred the sale and transportation of rabbits after 26 cases within 15 days.

The disease is acquired by handling the flesh or entrails of infected animals with the bare hands, or through the bites of various tularemia infected insects, in cloding the Rocky Mountain spotted fever tick. An ulcci usually marks the site of infection, appearing two to eleven days after infection. If the infection is from an insect bite, the ulcer usually appears on the neck, face, hands, or arms or other exposed areas; if from a tick, any part of the body but the feet, if from contamination through handling infected annuals, on the hands, Chillsand fever, profuse sweating, and painin all muscles follow.

The active organism is Bacterium tularense the name of the disease being derived from Tulare County, California, where the first outbreak among ground squirrels was discovered in 1912. Cottontails, jackrabhits, and snowshoe hares cause 90 percent of the human cases, although the disease also is carried by sheep, tree and ground squirrels, sage hens, red fox, ground hogs, muskrats, skunks, cats, dings, and opossum.

Health officials advise wearing rubber gloves when handling rabbit carcasses, protection against insect bites when in the woods, and extra precautions and prompt treatment if exposed.

Most of three diseases are well under control. The few exceptions fortunately are diseases which can be craditated by forceful action on the part of public health officials and intelligent co-peration by the general public. Trichinosis, for example, can and will be controlled as soon-as the public awakens. Rabies will be reduced to an unimportant discase as soon as dog owners voluntarily or under compulsion follow the advice of health authorities. Care in the use of raw milk will prevent bovine diseases.

On the Site of Armageddon

RMAGEDDON, ancient city mound A of Megiddo, in Palestine, around which was a frequent battlefield of the ancient nations, apparently was a walled city as early as 3000 B.c., according to Gordon Loud, field director of the Megiddo Expedition of the Oriental Institute of the University of Chicago, The expedition has excavated more than 150 feet of a great stone wall 15 feet high and 21 feet wide, which probably encucled the entire city site. The city mound has been built up from the debris of some 20 periods of civilization. The expedition inade a large cut through one section of the mound only, but the wall continues into the unexcavated portion

Characteristic of early Bronze period constraints, the wall shows considerable skill in the workmanship of the points of the rough innestone blocks. The two faces of the wall are much more carefully constructed than the uner part, which was filled with stone and rubble daybardering the original theologies. Of 12 feet was inadequate, for the construction shows that the width was later doubled.

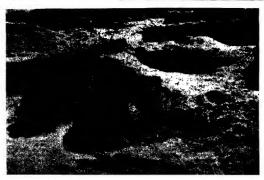
In completing the cut, the expedition reached bed rock—a soft, chalky limestone which slopes away from the site Bed rock is immediately below the 20th level of culture represented in the mound.

The cut exposed one cave in the soft limestone which may have been the home of the first inhabitants of the famous site. Neolithic finits, and sherds and liones were found in the cave.

Part of a large, ornamented flagged paving at stratum 19, about 3000 B.C., was disclosed by the cut. Outline drawings of horned animals and of human figures were incised in the stones of the paving.







Top: Ancient city wall exposed by excavations at the third level from the hottom and the eighteenth from the top of this very ancient "stack of paracket" (un-exposed city levels). Dump cirs and a light nailroad used in excavation show in background

Above: An animal cut in a flagstone covering an area at the culture level dated about 3000 years before Christ

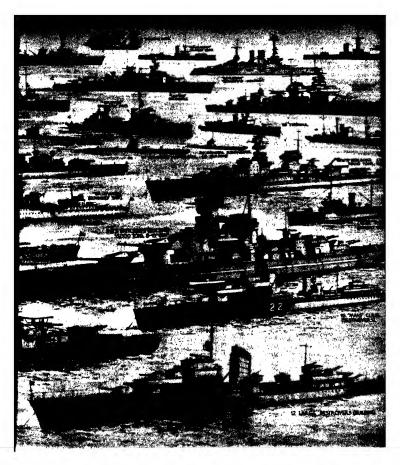
Left: Storage bins cut at the very bottom of the big mound—ut and used when, at the very heginning, there was but one city on the Neolithic site



THE GERMAN NAVY AT A GLANCE

Pirom 'pocket battle-ships'. Immed in size to 10,000 tons—
up to actual battle-ships of 35,000 tons, Germany has expanded her navy effectively in recent years. In this drawing by
Oscar Parkes, third of the series which we publish through
the courtesy of The Illustrated Lundon News, are shown typical ships of the new German navy. It will be remember that
in the 'Anglo-German agreement, Germany's tonnage in no

category except submarines may exceed 35 percent of British tonasge. This restriction is not, however, as stringent as the bare figures would indicate. Greater use of welding and of lighter metals has enabled Germany to devote a larger proportion of tonasge to protective armor and to crowd greater fire power on a given hull. This practice, first observed in the "pocket battleships," will make the new 35,0004on battle-



ships higger and presumably superior to sundar new ships mother navies. While the drawing (made some time ago) in-dicates two or three such 35,000-sumers, recent reports have it that three are now under construction and a fourth one is suthorized. The first of thees, the Binnaré, was launched last February. These ships will mount eight 15-inch guns. These guns do not have the range of 16-inchers, but the Germans seem convinced that firing observation from planes, as is necessary with the greater distances involved with the larger

guas, is ineffective. Accuracy of fire would be spatied from the ship herself Furthermore, use of the smaller guas gives an enormous saving in weight, for the 15-inch gun weighs only 844 tons as against 1270 tons for a 16-inch gun. Since the German constructors are still pledged to the pre-war tradition of constructional strength that enabled German ships at Jutland to take a terrific punishment without anking, it may be assumed that this saved weight will be used in providing greater structural strength as well as added armor.

YOUR INFERIORITY COMPLEX

EVERYONE starts life with feelings both of inferiority and of superiority.

On the one hand, he can not help having his interiority impressed upon him continually. He is constantly overshadowed by his big, strong parents (and other adults) who can do just as they please with him He can not even get through a door without their help—he is not tall enough to reach the doorknob —and can only stand and yell until some

one comes to assist him.

Things he does with immense effort, or fails to do after endless trials, the grown-

ups do without half trying

How could be help feeling weak and inferior? If he didn't, there would be something the matter with his mind!

On the other hand, the mlant is meatiably egocentric, completely cellish, and impressed with his own importance To himself, he is more important than any thing else in the world Lacking perspective, lacking experience of life, larking ability to judge his own powers, and having a strong will to dominate others (perhaps finding that his parents and others can actually be dominated, or course in develops feelings of super-

Damp the process of development, these strong but contradactory feelings gradually modified, tempered, and inseed moto a normal outlook on the world in which the individual recognizes both his own capacities and his own limitations, profits by both, and reaches a balance which represents entomal maturity, good mental hygene—in a word, sanity

Many, however, never attain this balance. They are overweighted in one direction or the other. They become the victims of complexes.

A complex is merely a group of related ideas strongly colored by emotion Because of this emotional tone, it has the tendency to attract to itself and incorporate in itself all sorts of other and originally unrelated ideas.

One may develop a superiority couplex because he is clever, finds that he can do things better than other people with whom he is associated, gets along easily where they struggle desperately in short, because he is riding on top of the waves. ("It's not concert," waid the Bishop; "it's just the consciousness of superiority!")

Even at its best, however, the superiority complex is largely an infantile type of behavior. The genus does not

Few of Us Attain that Perfect Balance Between the Two Extremes of Actual Inferiority and Self-Importance that Constitutes Emotional Maturity

By PAUL POPENOE, Sc.D.

Director, The Institute of Family Relations, Los Angeles
Lecturer in Biology, University of Southern California

inderestimate his own capacities, but he is mature enough, has a broad enough outlook, to know that there are, and have been, other able men in the world, and that none of them has the wisdom to inderstand fully even the affairs of every-

day life.

Indeed, the greater a man is, the more likely is lie to be modest and genuinely humble, as seen almost universally among the great men of science.

The man with a superiority complex is therefore stelly a bright boy who retains the infant's egocentreity, liss not grown up chough to recognize his own hintations, and will never be, emotionally, anything more than a precondally, anything more than a precondant somewhat spoiled child. He has the "Little Jack Horner" complex (There is another type of conceit which is merely an over-compensation for an inferiority complex and will be described later.)

THE inferrority complex is probably to commoner, and one hears of it much too often. The idea is by no means new-probably it goes back far beyond Aesop—but in recent years it has become a part of the common vocabulary. A student thinks his failure in college is sufficiently explained by the glib assurance, "But I have an inferiority complex!"

As I pointed out above, the inferiority complex has a perfectly natural basis in the experience of childhood, and everyone carries through life what might be called a normal inferiority complex, which is largely responsible for his achievements. He works to accomplish something because he recognizes that it has not yet been accomplished, and he is not satisfied with his own lack of knowledge.

If Einstein had felt perfectly satisfied after mastering Newton's ideas of gravity, he would have gone no fattler. He would have said to himself, as Buddha did when he stood under the sacred Batree, "I know it all!", and would have been content to spend the rest of his life imparting this knowledge to his students.

It was his discontent, his feeling that he did not understand, which made him continue to work on the subject

In a very real sense, therefore, this normal inferiority complex ("Not as though I had already attained") furnishes the driving power for creative achievement

But the name is usually reserved for an almormal or pathological state which (due to the tendency of the complex to draw unrelated ideas into itself) leads the individual to depreciate Innueff, to become undily sensitive, to be too eager for prase and flattery, to adopt a derogation attitude toward others.

All this, again, is largely a survival of infaintle attitudes which, facing adult difficulties, build up for their possessor a more or less organized system of ideaconcerning his own place in the world

Such an inferiority complex may have grown out of some personal handicap, some physical deformity, or it may be an environmental handicap; or both.

If a gurl is quite unaturactive, she may easily develop an inferiority complex; but she may likewise do so because her parents are divorced and she feels that she is therefore not like other girls; that she lacks something which they, happy in their home life, have had.

This boy grew up subject to constant taunts and ridicule because he was attaunts and ridicule because he was knock knoed. That one has just as much of an inferiority complex, but it is because his parents made him feel a failure when it transpired that he did not have the talent for mathematics which his old, or brother possessed, and was constantly bringing home from school low grades in that subject.

There is almost no limit to the possible points of origin of an inferiority complex Once it becomes established, of course,

t makes its possessor very uncomfortable. He reacts biologically by trying to get rid of this feeling—by trying to make himself more comfortable.

If he can not do this in conscious and useful ways, he will find some unconscious method of easing the situation. He may repress the whole thing in his mind,

so that it no longer obtrudes itself on his attention. He may regrest, that is, drop back to more childish ways of behaving, and try to get the consideration from others that he enjoyed when he was an infant and was not expected to accomplish much. He may daydraem, creating for himself an imaginary world in which he can rule as he likes—where he can select the most beautiful movie star as his quere, where he can turn everything into gold at a touch, where he can tell the boss tust where to get off!

Characteristically, however, the victim of an inferiority complex attempts to escape from his discomfort by compensation—that is, by some sort of mental activity which will bring him feelings of personal worth not attainable in the usual way, and which will thereby onable him to "forget" his feelings of inferiority.

These "attempts to compensate for an inferiority complex" have become traditional; they are innumerable and extra-ordinarily diverse in form; which one of them an individual unconsciously selects will depend on his own background and personality. Among the best-recognized of them are the following:

1 Bluffing.

The boaster and the bully alike are open to asspection of trying to cover up their own feelings of inferiently. The test to challenge them in the very field in which they profess particularly to excel if a man tells you that he has a grand opera voice, ask him to sing before a group. You will suddenly learn that he as a slight cold; or he needs his own special accompanist. The bully is not rously ready to fight at the drop of a hat —but only with one smaller than himself. Equally noticious is it that the man who is constantly boasting of his excual provess is likely, in fact, to be impotent.

Similarly the aggressive back-slasper who knows it all, who is never arguing but always just telling you, who laughs bloudest and talks most, who is blustering or snobbish as the case may be, and who is often supposed to have a superiority complex, is much more likely to be suffering from an interiority complex, which he is trying to cover up. 2. Posing.

This is a little more subtle than the bluffing just described. It affords wide scope for the subject's imagination and his ability to dramatize himself.

Mr. W., for example, is a prophet. He is always predicting what will happen and he insists that you attach great importance to his telling you so. "Mark my words" is an injunction even dearer to him than "I told you so"—and usake much more frequently. By dealing only in future events, he can avoid having to face realities. He can attract enough attention for his purpose by assuring the bystanders in the most solemn manner—and adjuring them particularly to remember that he warned them—that

America will have its first communist president in 1948. He knows that in the intervening ten years everyone will have forgotten him; but for the present he gets a minute's immersion in the grateful warmth of the limelight.

Mr. B., similarly motivated, is "an inventor." Nothing stands to his credit in the Patent Office, and his rent is often unpaid, but he continues to be mysterious—much as he trusts you. he dare not



"The greater a man is, the more likely he is to be modest and genumely humble, as seen almost universally monny the great men of senerce." Prof. Einstein, whose manner is suterly natural and simple—not seen the series of the s

confide even to you what he is working on: it might cost him his life. Meanwhile,

at is at least a good alibi for laziness. Mr. G. credits himself with profundity, which he impresses on you delicately by talking over your head. He likes the words in the back of the dictionary, Of course you understand the "center-standive principle of procedurity". Not entirely Well, that's too bad; but then, it's no use for him to try to explain—you wouldn't be able to follow the discussion.

And so on through an endless procession of posers, many of them not merely harmless but amiable, who help to entertain the world and fool no one except themselves. They are all trying to cover up their inferiority complexes by a show.

3. Passing it on to others.

If one feels inferior, he can always find someone else whom he considers even more inferior and, by comparison, make himself feel quite a personage. Much race prejudice stems from this source. The "high yellow" Negro looks down on the ordinary mulatto who in turn considers himself much superior to the black. Among Jews in America, those of Mediterranean ancestry consider themselves socially superior to the German Jew who, in turn, does not like to accept the Russian Jew as an equal. 4. Reforming others.

One who is trying to redeem people from their vices or sins can scarcely help feeling superior to the unfortunates whom he is uplifting. As he looks at the drunkard, the virtuous man may say. "There, but for the grace of God, go I"; but unconsclously he can scarcely help reflecting, "At any rate, I don't go three."

Moreover, psychologists generally garee that when a man shows a particularly strong emotional aversion to some human frailty, it is likely to mean that he himself has a strong unconscious tendency toward that frailty. Zeal in retendency toward that frailty. Zeal in retendency toward that frailty. Zeal in retendency toward that frailty can be sometimes and thereby enable him to live more at peace with himself.

5. Rationalization.

This is the process of dressing up an unpalatable fact so that it becomes attractive, It is a common component of mental life. As the late old J. Pierpont Morgan once remarked: "A man always and so two reasons for doing anything—a continuation, or the process of finding in condition, or the process of finding in good reason," is particularly employed to compensate for an inferentity omplex.

The "sour grapes" attitude is proverbial. The "sweet lemons" attitude is merely another manifestation of it, exemphified by Pullyanna and more pretentiously by the old philosophy that "Whatever is, is right."

Mr O is afraid to marry. He is afraid of life, fariad of sex, afraid of himself Naturally, he won't confess these fears, even to himself; won't admit that he thinks no woman could be attracted to him, and that if she were he couldn't hold her. He will rationalize. He will continually prasse marriage and explain that it is so important that he doesn't want to make any mistake when he marries. One shouldn't marry until one finds just the right girl. If you know Mr. O., you know that he will take great pains never to find the right girl. O. Humultry.

A common and tiresome device of people with an inferiority complex is to disparage themselves. Dickens' famous character, Urah Heep, was continually announcing that he was "the most 'amble person' that ever lived. The girl who is not sure of hereel! is incessantly reminding you that nobody loves her. The scientist with an inferiority complex asserts at every opportunity: "I know absolutely nothing about this subject."

Of course, all of them want merely to be contradicted. The bait is annoyingly



Urish Heep and David Copperfield. "'Umble as I am," says Urish to David

obvious. The girl wants to be told: "Who could help loving you?" The scientist wants to hear you say: "If I knew one tenth as much as you do about it, I'd be a wise man." They would be considerably disconcerted if you merely agreed with them!

7. Throwing up a cloud of dust.

Everyone knows Mr. L—the type of bosnesse man who is always in a hurry, always "going through the motions." If hasn't a moment to stop and talk with you because there are so many hig deals awaiting his attention at the office. While he is telling you about them and lamening the tremendous pressure under which he lives, which doesn't permit him to stop a minute to pass the time of day with a frend, he has killed half an hour of your

Arriving at the office, he agas one letter while he is opening another, grabs the telephone at the same moment that he lights a cigar, calls his senographer before he takes off his overcost—and keeps her standing idly by while he cleans out the drawers of his deak and then telephones to a friend to talk about the good time they had at the club last

night.
His roum is littered with Work-Organizers, Time-Treasurers, Fact-Finders, Future-Filers, Appointment-Announcers, System-Establishers, Ready-Reckoners, Second-Savers, Minute-Makers, and Efficiency-Increasers.

The general result of this pressure of activity is the same as that obtained by a small boy when he puts the gears of his father's automobile in neutral and then steps on the accelerator. The car doesn't go anywhere, but it does produce a very satisfying lot of nouse and vibration.

This pressure of activity, which throws up a cloud of dust in which no one can see just what the thrower is accomplishing, is a common way of covering up a feeling of inefficiency, inadequacy, and inferiority.

8. Hitching your wagon to a star.

One of the most "high-toned" ways to avoid competition and to escape the possibility of defeat is to adopt some lofty

and unattamable goal. Prof. M. has been working for 20 years on some sort of chemical process. No one except himself knows quite what it is, but everyone knows that it is very important -definitely fundamental, in fact. He has actually done an immense amount of routine work. He assures you that he isn't the man to "rush into print" with a halfbaked announcement; he is going to publish as soon as he has really completed the job. Since it is humanly impossible to complete such a job, he will die unpublished: meanwhile he has more of a reputation than he deserves because people take his hints seriously and don't know that this pose of profundity merely serves as a cover for aimlessness and futility.

Miss F. is going to marry as soon as she finds the right man. The man who gets her will have to be a good man. In fact, he will have to combine in one person all the beat qualities of Robert Taylor, Edsel Ford, Max Schmeling, Glenn Frank, Henry Cabot Lodge, Gary Coper, and Nelson Eddy. Since few of us mere males can attain such a composite standard of excellence (though of course most of us come very close to it), Miss F. will unquestionably die unmarchably die unmarchably die under the description of the control of the control of the composite of the control of the con

This device of setting up a fictitious and unattainable goal is a particularly good one because it seems to denote a lofty spirit, and because of course there is much truth in the idea that "Not failure, but low aim, is crime," and so on, as poets and philosophers have remarked

at great length. But the goal should be at least reasonably realistic. While one man is "standing by," waiting for a chance to get a hitch on to a star, another has hitched his wagon to a tractor and accomplished a good day's work.

All these compensatory mechanism, and others that will occur to the reader's mind, help to make life interesting. Few of us can pretend to have avoided them altogether. But when they lead toward false goals, when they prevent worth-while achievement, when they merely reflect inadequate personallities, they need attention.

The practical question, then, is: What can be done with an inferiority complex?

1. Recognize your disabilities

Don't try to fool yourself. Unfortunately, it is much easier to fool yourself than to fool others. They can see you plainly because they don't look at you through an emotional fog as you look at yourself.

It's just as great a mistake to exaggerate your disabilities as to depreciate them. Expert appraisal by a disinterested person will often help you to correct the perspective.

In the case of mental qualities, emotional attributes, special talents, and professional aptitudes, the use of some of the modern batteries of tests may be a great help. No one pretends that they are micrometrically accurate, but they are good rough-and-ready measurements in the hands of one who has the training and experience to interpret them. Measurements of this sort should be given to every young person, as a routine procedure, somewhere in the high school period. They would help boys and girls to find their places in the world without too great a tendency either to over-value or to under-value themselves. They would

keep square pegs out of round holes.

2. Overcome your disabilities if possible.

The process of doing so is often the road to achievement. The elder Theodore Roosevelt was a puny boy: by determination he overcame this handicap and developed into the exponent of "the strenus life." Ted Shawn determined to outgrow the effects of infantile paralysis and became an outstanding dancer. The story of Demosthenes overcoming his speech impediment by talking with pebbles in his mouth, and developing into the greatest orator of his time, may not have much historical basis, but it is at least symbolic of what many another has accomplished under the stimulus of a will to overcome.

3. If you can't overcome a handicap, act as if you didn't have it. As Beethoven became deaf, he worked with more and more industry at his musical composition, turning out better and better work.

Finally, develop your strong points.
 Find out what you can do successfully, and do it.

Staticless Radio

Invention Opens Up New Uses for the High Frequency Channels . . . Receiver Automatically Rejects Static Impulses

EDITOR'S NOTE: The radio system described below is for use on the short waves only and cannot be adapted to the standard broadcasting waves.

THE first high-powered, staticlew radio station in the world employing a "frequency-modulated" system of transmission and reception, will be but into scheduled operation early this year, with the call letters W2XMN, it is announced by Major Edwin H. Atmstrong, professor of electrical engineering in Columbia University, who designed and built the broadcasting equipment.

ment. The new system will use an invention of Major Armstrong's which wipes out static, tube noises, and interference. It will greatly relieve the danger of the arr waves being monopolized, which has given so much concern to Congress. by making possible a service on the ultrahigh frequency channels that are comparatively unused at present.

Construction of frequency-modulated receiving sets of the new type has already been started on a commercial basis by General Electric. The new sets, when produced on a quantity basis, will cost today and will be able to receive both the old and the new kinds of broadcasting much the same as sets now receive both the short- and long-wave programs.

Station W2XMN, built in a wooded section of Alpine, New Jersey, atop the Palisades, has a 400-foot tower with three 150-foot crossarms. The aerial consists of a series of copper plated steel bars fastened to a boom suspended between the tower's crossarms. The adjustment of this antenna proved to be the most difficult part of the whole construction. For a period of two months last summer Major Armstrong sat in a boatswaln's chair several hours a day, 400 feet up, regulating the transmission lines. "As this had to be done with the power on; the combination of dodging the high voltage and the frequent thunder storms made the day's work always an interesting one," Major Armstrong said.

Two similar stations, build on an experimental scale, are in existence, one in Albany, New York, owned by General Electric, and the other at Storrs, Connecticut, erected by Professor Daniel Noble of Connecticut State College. Six other stations are being constructed in the cast.

W2XMN is at present licensed by the Federal Communications Commission to broadcast in the vicinity of 40 megacycles, which corresponds to a wavelength of about seven meters. While this is an ex-

tremely short wavelength judged by ordinary broadcasting standards, the invention can be used equally effectively on still shorter wavelengths.

The new frequency modulation differs from the amplitude modulated transmitter now in use in that the frequency broadcast by the improved method is changed in accordance with the fluctuations of the voice, and not the intensity of the radiation, as in the existing amplitude modulation method of broadcasting.

FIEQUENCY modulation programs, at any given listening point within the range of the station, will, in general, have from one one-hundredth to one moethousandth the disturbance of programs broadcast by the present method, it is claimed. This means much better reception within the service area for the mew station, conservatively estimated at 100 miles. The receiver automatically rejects a signal that is too weak to be received satisfactorily, such as man-made or natural static noises, but receives all waves sent out from the high-powered transmitter.

In addition to the advantages in sound production, it is said that the method



The tower of W2XMN, designed for use with the new Armstrong staticless radio system

can be used for multiplex sending, and that as many as four programs have been simultaneously transmitted and received by one transmitter and one receiver. The theory on which the system works is a direct reversal of that on which engineers have previously worked to eliminate noises. The old principle has been to narrow down extraneous sounds, while the Armstrong system does just the opposite. It is this necessity for a wide band which rankes the new system impractical on the wavelengths now customarily used for ordinary broadcasting.

When the invention was demonstrated before the Institute of Radio Engineers as sound-real recording was played, comparing the reception during a thunder sorm of the old and new types of broadcasting. The recording was made from most of the recording was made from most of the recording was made from most of the recording was made from modulated station, and from WEAF, as Sokilowatt station, and from WEAF, as Sokilowatt station, and from WEAF, as obtained in the station of the requency-modulated signals provided an uninterproted, clear program, free from static, despite the fact that its power was only 4 percent of that of the larger station.

HEN an automobile manufacturer wants to know whether the springing of his new model is adequate, or the radiator large enough, he does not have the car driven over smooth concrete roads. He puts it in charge of a test drive who "gives it the works," as it were, by taking it over rough country and making it od all manner of thinge an ordinary driver would never

Similarly, in scientific research, much more can be found out about the way materials behave, and the way molecules behave, if they are tested in unusual circumstances. Sometimes high temperatures are used, or strong electric fields, or high pressures, or very low temperatures. It is with the last that we

are concerned here.

When scientists write about low temperature research, they are thinking of temperatures about 450 degrees below zore Fakrenheit, or about -270 degrees centigrade. In some of his experiments, the scientist ries to reach as low a temperature as possible, and it is at least comforting to know that there is a natural limit of temperature beyond which he cannot go, and which represents the greatest degree of cold attainable, or even imaginable. This absolute zero is at 273 degrees below zero centgrade. Nothing hiss ever been quite as

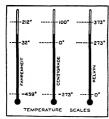


Figure 1: Three temperature scales, the Kelvin being the most logical

cold as this, but very nearly, within a few hundredths of a degree, in faet, But those last few hundredths are the hardest ones to surmount A temperature of -275 degrees C. not only has never been attamed, but it is just as much a contradiction in terms as a square circle or a wooden piece of steel. To make the numbers smaller, temperatures are often reckoned from the absolute zero as a tatriting point, and when this is done, the Kelvin scale results (Figure 1). Thus a temperature of 4 degrees K. is

THE CURIOUS CASE

Wherein a Liquid is Discovered to Behave like a Cat-footed Burglar and to Puzzle Scientists by its Extraordinary Fluidity . . . Still Is a Puzzle

the same as -269 degrees C., and the boiling point of water, 100 degrees C., is the same as 373 degrees K.

Everything is frown solid at temperatures below 14 degrees K., except belium, the light gas that is used in airships. Hydrogen, the next best thing, melts at 14 degrees K. and boils away to hydrogen gas at 20 degrees K. Liquud air is really hot—it freezes at 55 degrees K. K. and boils at 91 degrees K. All these sold substances, of course, must be kept in double-walled Thermos bottles.

Low temperature research is complicated and expensive. Only a few laboratories are well equipped for it. The most abtable on this continent is at the University of Toronto, where Professor Burton and his colleagues make about a quart of liquid helium weekly.

LIQUID helium boils at 4.2 degrees K., at atmospheric pressure. If the boiling is quickened by pumping off the gas, the increased evaporation lowers the temperature gradually. Meanwhile the liquid boils vigorously. All of a sudden, at 2 19 degrees K., the liquid seems to stop boiling; at least it is quiet, but evaporation continues, as shown by the gas which can be pumped off, and the gas which can be pumped out, and the temperature keeps on falling. This obser-vation is merely one of many which show that the temperature, 2.19 degrees K., marks a transition point between two states of helium. For want of better names they are called helium I and helium II. Helium I is the warmer, helium II the colder. The name λ-point (Greek, lambda) is given to this transition temperature.

non-temperature. Some properties make liquid helium presentrabel fluid. We think of the liquid helium presentrabel fluid. We think of its weight just pere 2 pounds. A quart of liquid helium would weigh only about 5 because 10 liquid helium would weigh only about 5 because 10 liquid helium would weigh only about 5 because 10 liquid helium would be the liquid helium because the liquid prosesses an unusual heat conducting capacity for in excess of helium 1, and some time age Professor Kapitza thought this might be due to an abnormally high fluidity—or low viscosity, as the physiciats call it. This would mean that the liquid would circulate with extreme case, partying heat by means of convection. currents.

Peter Kapitza will be remembered as a Russian scientist who spent many years in Lord Rutherford's laboratory at Cambridge, England. First he was interested in producing very strong magnetic fields, which he accomplished successfully. Then he turned his attention to research at low temperatures, among other things, and a special laboratory was constructed for him, complete with helium liquefier [described in Scientific American, December, 1934, pages 300-302.—Ed.]. Then, suddenly, while he was on a holiday in the U.S.S.R., the government apparently declined to let him leave, but offered him adequate facilities for pursuing his work in Moscow, The difficulty then was to know what to do with his new equipment in Cambridge, for a scientist's own research equipment, minus the scientist, is rather like a ship without a rudder or engines. Finally some of the equipment was purchased by the U.S.S.R. for Kapitza's use, and his friends were pleased to see in Nature, a little more than a year ago, a letter recording some of his experiments.

Kapitza, then, set out to measure the fluidity or viscosity of helium II. The usual commercial methods, or even the usual laboratory methods, were not very convenient at 2 degrees K., so he devised the following scheme. A tube (A, Figure 2, left), had fixed to its lower end a heavy glass plate B, with a hole through the middle. Below this was another plate C, whose distance from B could be varied by devices that the diagram does not show. The inner surfaces between B and C were optically flat. Then B and C

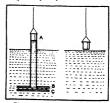


Figure 2: Left: Kapitsa's experiment. Right: The suspended beaker

of Liquid Helium

By THOMAS H. OSGOOD, M.S., Ph.D. Head of the Department of Physics et the University of Toledo

were fixed at a convenient distance apart -let us say 1/32 inch-and the whole thing was lowered into a bath of liquid helium II. Soon, the two levels, inside and outside the tube, were the same. Now for the experiment, The unit was muckly raised a short distance, making the level inside A higher than outside. This inner level was expected gradually to fall, as the liquid leaked out between B and C. But it fell faster than was expected, In another case B and C were placed in optical contact, meaning that they were pressed firmly together. You would think that the helium II inside could now hardly escape. But you are wrong. The inner level of liquid settled down in a few seconds. Here was a curious liquid, one that could slip in a few seconds through a space about a thou-sandth as wide as the thickness of a sheet of paper!! Indeed, in all the previous history of physics, no substance ever before displayed such remarkable fluidity; upon calculation, this helium Il. a liquid, turned out to be about 10,000 times as easy flowing as hydrogen gas. It sounds almost incredible. But how to find out the truth?

THE next step is an obvious one, once it has been pointed out. If helium II can slide through cracks as casily as Kapitza's experiment showed, surely it is worth while trying to see whether it can slide through no crack at all. A report of experiments of this kind was published in the middle of 1938 by Daunt and Mendelssohn of the Clarendon Laboratory, Oxford, England, but they were careful to point out that their experiments were merely an elaboration of an observation of Kammerlingh Onnes of Leiden (in 1922) that the surfaces of two volumes of liquid helium II in two concentric vessels, adjusted themselves automatically to the same level, Daunt and Mendelssohn suspended a tiny glass beaker (Figure 2, right) by a fine fiber so that it could be lowered into or raised from a bath of belium II. Here are their own words to describe the effects. "When the empty beaker was lowered into the liquid, it filled up to the level of the bath, although the rim of the beaker was everywhere above the level of the liquid. When the beaker was partly lifted out of the bath, the level of the liquid in the beaker fell . . . and the level of the bath rose until both had reached the same height. In order to establish whether the transfer took place by distillation . . . or by transfer over the surface, the effect was examined of introducing wicks of twisted copper wire which increased the surface leading from one level to the other. It was found that this increased the rate of transfer to several times the previous rate so long as, but only so long as, the wick reached into the liquid at the higher level. When the beaker (without a



Figure 3: Apparatus for making li-

wick) was completely lifted out of the bath, it was found that the liquid vanished at the same rate as when it was still partly dipping into it. This was accounted for when it was observed that the liquid collected in drops at the bottom of the beaker and dripped into the bath. The rate of transfer did not appear to differ very greatly whether the beaker was almost full or nearly empty." And the authors add, in conclusion: "If any of these phenomena occur above the \(\lambda\)-point (that is, with helium I) the rate is so slow that they could not be observed in our experiments."

Thus it seems clear that the surface of a solid in contact with helium II is covered with a helium film which transports the liquid to the lowest available level, and that the helium II creeps over the cold surface in an uncanny way. No wonder Kapitza was misled in the interpretation of his experiments! What happened, of course, was not that the helium II slipped through the crevice between plates B and C of Figure 2. left, but that the levels were equalized by the liquid creeping over the top of the open tube A. Perhaps "creen hardly the right word, for the moving film of helium is so thin that it must move at a speed about equal to that possessed by the molecules themselves a few hundred meters per second, that is several hundred miles an hour.

LATER experiments in several labora-tories, especially at Toronto, have shown that the fluidity or viscosity of helium II is not nearly as low as Kapitza suggested. It turns out to be about the same as for gaseous hydrogen. But this in itself is low enough to set the theoretical physicists to work to try to explain why the helium II has these superfluid properties. The theories which are being proposed make the assumption that helium II is a sort of a cross between a gas and a liquid-a degenerate Einstein-Bose gas, to use the technical term. The problem is essentially this: In a gas, the molecules are, to all intents and purposes, quite independent of one another; the only thing that rcstricts them is the solid wall of a container, such as the shell of an oxygen tank which keeps in the oxygen. But open the valve, and out the oxygen rushes. On the other hand, the molecules in a liquid always stay at about the same distance apart. If you like a crude picture, you might say that the molecules are somehow hooked on to one another, by hooks which do not stretch. If you open a bottle of medicine, the medicine does not suddenly rush out into the room like the oxygen from the tank. In the case of helium II, then, the helium molecules must be attached to their neighbors by non-stretchable hooks, for the substance is a liquid. But at the same time, it can not have its extraordinarily low viscosity unless the molecules can slide past one another with the greatest of ease. This means that they must be able to change neighbors very readily. The question is, there-fore, what kind of "hooks" do these molecules have which are firm enough not to stretch, and yet which automatically couple and uncouple their neighbors, but do not let those neighbors go free?

The "hooks" of which we speak must necessarily be electrical forces. Whether or not the theoretical physicists are on the right track, time and further experiments alone will tell. But when it is known how these "hooks" work, a new discovery will have been made about molecular forces.



The attractive result, a gleaming and lustrous string of matched natural pearls, one of the finest of its kind now on sale by jewelers in this country

The lovely natural pearl has been for counties centuries the subject of speculation in fable, song, and story. The only gem that comes from the sea, and the only one made by a living process, it aroused long ago the intense interest of those who were able to use only their imaginations to conceive of its origin and characteristics.

Now, however, thanks to the advances of science, we can study this most interesting of all gems with a thoroughness that might have amazed its early admirers.

In a recent article in Scientific American we discussed the attempts that have been made by man to simulate the natural pearl, which nature alone can fashion. Despite the ingenuity of man and the wonders of science, no artificial or "cultured" pearl can be produced that can compare with that warm, rose-colored bit of loveliness from the Persian Gulf that is the handiwork of an inspired Mother Nature. And although cultured and imitation pearls are available, they bear a similar relationship to the natural pearl as gold-filled articles do to solid gold jewelry, silver plate to sterling, or reproductions to genuine old masters.

The entirely natural formation of the genuine Oriental pearl occurs, for example, where by chance a tiny grain of sand or other foreign particle enters an oyster shell, or where some abnormal condition results in the growth of a pearl.

This tiny particle becomes the nucleus of the gem. Layer upon layer of nacre is deposited upon this heart as the pearl grows. These films that form the pearl vary in thickness, being much thinner

Science Dissects

By A. E. ALEXANDER, Ph.D. Pearl Fellowship, Mellon Institute, Pittsburgh, Pa

than a sheet of tissue paper. The most lustrous pearls are those in which the constituent layers are the thinnest, while those of less attractive appearance are made up of thicker and coarser layers of nacre.

of nacre.

We have authority for believing that the pearl generally takes its color from the shell ling, and even from that part of the shell near which it is formed. A rose- or cream-colored pearl would not be expected, according to this explanation, in an oyster in which the shell lining is of any other color.

Pearls may be rose, cream, white, grey, bronze, black, pastel shades of lavender, blue, yellow, mauve, crange, brown, or green; but the more desirable colors are rose, cream, white, and black. The temperature and composition of the water and the state of health of the oyster are thought to determine the color of any green pearl. The appealing iridescence for which pearls are prized is due primarily to the reflection and refraction of light which take place on the surface of the geni.

THE beauty and aplender of the pear! An are been using in the sacred books of the Christians, the Hehrews, and other religions. St. Matthew, for example, had a high appreciation of this gem: "The Kingdom of Heaven is like unto a merchant man seeking goodly pearls, who when he had found one pearl of great price, went and sold all that he had and bought it."

bought it."

The gates of the Holy City were described as 12 pearls by St. John in the Book of Revelations. In the Talmud there is a reference to the pearl "that has no price," and also to manna that was "as white as pearl."

Hindu legend attributes the discovery of the pear It oKrishna, the form in which the preserving god Vishnu appeared in all his glory. According to this tale, he took the pear from the depths of the ocean to adorn his daughter on her wedding day. This is the source of the tradition that links pearls to hrides even to

the present.

In the classical period of Sanskrit literature, about the 3rd Century of the Christian era, there were abundant references to the pearl. It was generally called "mutka," the pure, and there were numerous words for pearl bracelets, necklaces, and other pearl ornaments in the dramas of Kalidasa, the Hindu Shakespeare.

According to "The Kingdom of the Pearl," by Leonard Rosenthal, it is beleved that pearls were the first gens known to man. It is bleely that the discovery of the pearl was made by some member of a fish-eating tribe on the shores of India. The Ancient was possibly estracted by the brilliance of the gen when he opened the mollusks that were mitteded for his food. As his natural taste for heauty developed, he used it to satisfy his deser for adornment, which characterizes alike the most primitive tribes and the most refined civilizations.

The Chinese knew and appreciated the pearl at a very early date. The gens were accepted by them in payment of tribute. Some fantastic Chinese tales tell about pearls so brilliant that their glow could cook rice at housand miles away. And about the beginning of the Christian Era it was reported that one pearl was found so lustrous that it could be seen in the dark at a distance of three miles.

The tale of Cleopatra drinking wine in which she had dissolved a pear! from an earring is known to every student of legend. Science, however, must modify the story by pointing out that a pear! cannot be readily dissolved in sour wine unless it is first powdered.

But there is record in subsequent history of the drinking of a valuable pearl. During the reign of Queen Elizabeth, Sir Thomas Gresham, who possessed a famous pearl worth 15,000 pounds, ground it to a powder, and drank it to his sovereign's health when he was entertaining the Spanish ambassador at dinner. His purpose was to show the Spanish of what luxury the English were capable; and probably, also, to prove that England had the wealth to raise a fleet to protect hersel!

Catherine de Medici owned the most exquisite pearls in the world, according to the historian Bapts, when in 1533 she married Henry, Duke of Orleans, afterward Henry II of France. She had two large pear-shaped pearls weighing about 92 grains each, which were presented to her by Francis I, and which she later gave to Mary Stuart.

Of the very large pearls generally mentioned by writers, three undoubtedly exist: La Pellegrina, the Beresford Hope,

THE PEARL

Oldest Gem Gives Up Its Secrets . . . How and Why Make-Up Varies . . . Iridescence . . . Nucleus Usually Absent . . . Microscope, X Ray, Other Tools Used

and one of medium quality in the Austrian crown weighing about 1200 grains. The finest is La Pellegrina, which is perfectly round and so lustrous that it appears to be transparent.

For many centuries the finest pearls in the world have come from the Persan Gulf, cheffy from the waters around the Island of Bahrein Here, most of the population depends for Irvelihood upon pearl fishing, according to a British writer, on whose recent account some of the material in the next few paragraphs.

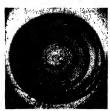
is based. Some 75,000 natives depend for their living on pearl diving, as have their ancestors for nearly 2000 years.

The present ruler of the tuny independency is Shakh Hamad bin lea al Khalifah, a member of an ancient Arab family which came originally from the manland of Arabia. Though he cnourages mudern methods and improvments, he lives as an Arab Shaikh, always wearing the dress of ha country, surrounded by picturesque retainers, and spends much of his spare time in hunting, coursing with Saluki hounds, and in hawking.

Although the richest pearl banks in the world are around Bahrein, the Shathh receives no direct income from pearls. The revenue of his state is mainly derived from customs duties upon imports and from oil royalties. The value of importations, however, depends upon the success of the diving neason, which lasts from the middle of May until the end of September, while the water is warn.

On a day appointed by the Shaikh, which is announced by public proclamation, the pearling fleet, consisting of several hundred sailing dhows, very like

Roman galleys, sets out from Bahren to the pearling banks. Until they clear harbor, the boats are propelled by heavy oars, each pulled by two men, who sing the song of the pearlers as they row. Often the fleet returns at night when the moon and tide are full. The sound of the sallors chanung and the sight of bundreds of white sails colored orange by the



Section of a typical Oriental saltwater pearl, showing concentric arrangement of mineral matter throughout. An ideal pearl, structurally, Magnified about seven times

light of fires burning on the decks is, indeed, very picturesque.

The pearl divers use no mechanical apparatus of any kind, and the diving methods have changed little since they were first described by 14th-Century travelers. Each diver wears a clip like a clothespin over his mose, and leather abeaths to protect his fingers and to enable him to wrench the shells from the rocks underneath the sea. Each of his big

toes is guarded by a similar abeath. Grasping a stone as a weight, the descenda on a rope to the bottom. Around his neck is a strang bag, which he fills as rapidly as he can during the minute and a half he is able to stay under water. When the air in his lungs is exhausted, he gives the signal, and is pulled up to the surface by his companion in the boat. A good diver can descend about 30 times in a day, often to a depth of 14 fathoms.

The shells are piled on deck to be opened later under the watchful eye of the captam, who carefully guards the pearl treasure in a chest. The shells are thrown back into the sea, for the divers believe that oysters feed on them. They believe, too, that the pearls are formed by drops of dew that fall into the oysters.

at night!

The men receive no regular wages, but which share in the profits of the boat to which they are attached. The general principle of the diving system is fair, especially asnot the present Shashh delegates gowerment employees to check on the books kept of the season's catch. A certain percentage of the crew, chosen by the men of cach boat, must witness the sale of the pearls by the captain to satisfy themselves that they receive a proper share of the profits.

WHEN sold, the pearls go from Bahrein to the great markets of India. Here steps are taken to bring out their sublime luster. Each jewel is carefully washed and poilshed by expert workmen. Next, the pearls that are to be used in necklaces must be drilled by hand. The skilled craftsmen in charge of this step employ a delicate method of drilling that has not changed in 3000 reasons.

In India, the gleaming finished pearls are purchased by dealers who take them to Paris or London. To these pearl centers, buyers from this side of the Atlantic travel to select their stocks.

Interesting as may be the facts we have discovered, the scientist must delve still deeper into the physical characteristics of the pearl. Science must view not only the surface, but must go beneath it.

The best way to seek out the story behind the pearl is to examine its internal structure microscopically. To do



An ideal "Maltese cross" X-ray diffraction pattern (two exposures) produced from a cultured pearl of 7.36 grains



Two characteristic diffraction patterns produced from a natural pearl (7.44 grains) with fine concentric layers

this, one must thin-section the jewel. A pearl to be thin-sectioned is first ground on a coarse diamond lap or polishing surface until its maximum diameter has been reached. A few turns over a finer textured diamond lap will eliminate the acratches produced by the previous grinding operation. The pearl is next cemented to a microscope object glass, using Canada balsam. After the balsam has hardened, the remainder of the pearl is ground to wafer thinness, first on a coarse diamond lap and finally to a thickness of 0.03 millimeter on a lap of very fine grain. A cover glass is cemented over the specimen and the thin-sectioned pearl is now ready for microscopic examination.

The optical properties of the mineral matter are best observed using polarized light. From such a thin-section one finds that a natural pearl 18, in general, structurally not unlike an onion, in that the numerous layers of mineral matter are concentrically deposited from the innermost part of the jewel to the exterior Because of this interesting structural arrangement, a pearl can be "skinned" very much as an onion can be peeled.

HEMICALLY, the pearl is composed → almost entirely of calcium carbonate. This material, on examination, is found to be deposited around a tenuous network of organic matter, which has been termed conchiolin, much like the enamel around the dentine of a tooth. Limestone and marble are composed of the hexagonal variety of calcium carbonate, calcitc. Few pearls have this mineral in their constitution. The form most generally present in pearl substance is the orthorhombic variety of calcium carbonate, aragonite.

The gem, exquisite as it is, is in a sense an abnormal growth. Unlike other concretions and pathologic products in ani-

mal and vegetable life, however, it is strikingly beautiful in its evidence of disordered physiologic change. In the case of the pearl-oyster, some irritation is presumed to have been set up in the musculature system of the mollusk. The microscopic irritant, if from an external source, may have been of organic origin perhaps some species of trematodeor, again, it may have been inorganic in character, as for example, a grain of sand or an agglomerate of silt. The mollusk, unable to rid itself of the unwelcome intruder, seeks to reduce the attendant irritation by coating the substance with nacreous material.

Certain epithelial cells within the mantle of the oyster have the ability to extract from the sea water those salts necessary to produce calcium carbonate. It has been stated that it is not temperature that controls the crystallization of calcite and aragonite so much as it is the acidity or alkalinity of the carbonate solution. Calcite crystallizes from an acid solution while aragonite forms under alkaline conditions.

The interior of some natural pearls has been found, in instances within the writer's experience, to consist of coarsely crystalline calcite around which have been deposited concentric layers of aragonite. In the case of this particular, pearl, then, the physiological state was such that only calcite could be deposited in the beginning. Later, the physiological-chemical processes of the pearloyster changed to the extent that alkalinity prevailed and calcium carbonate

in the form of aragonite was laid down Many natural pearls, when sectioned. reveal no evidence whatever of an irritant. From this observation we must assume that the nucleus has been of organic nature or perhaps of internal origin. Shortly after deposition began, decomposition of the organic matter ensued, with the result that the final product reveals no evidence of what initiated the process.

To look further into the subject of iridescence, we must call on the principles of optics, in order to explain how light acts on transparent and translucent substances in thin films. Light entering a medium, unless the latter is amorphous



A natural salt-water pearl poss ing a central area composed of radiating crystals of calcite, around which have been deposited concentrically arranged layers of aragonite

in character, will deviate from its normal course. The beam reacting in this manner is said to be refracted. If light is directed on an object from an angle, a certain amount will be cast back into the eyes of the observer. This light has been totally reflected. On microscopic examination, using polarized light, the concentric lammae of natural pearl substance-viz, aragonite-are found to lie in a basal plane; that is, in a plane perpendicular to the vertical crystallographic axis. These laminae are exceedingly thin and tenuous. Furthermore, they overlap one another. Their edges, when examined closely, resemble to a marked degree certain contour lines seen on topographic maps, which are used to designate rough and rugged country. The surface of a pearl, when examined microscopically, may not be entirely smooth in some cases. In fact, it may have a hammered appearance, not unlike that seen on hand-wrought copper.

"The modern trend toward specialization has reached the jewelry field, and the handling of pearls has become a definite specialty. Just as a dealer in fine paintings or rare antiques devotes his life to the study of these works of art, so does the pearl expert develop his skill to an uncanny degree in identifying and evaluating pearls. Not only have many of these specialists gained the ability to distinguish by the naked eye between a genuine pearl and a "cultured" product, but they can also tell by visual recognition the geographical region in which a pearl originated. In addition to the identifying work of

The deck partner of a pearl diver is holding the small string bag which the diver fills in a quick descent. Oysters are accumulated and are not opened until the end of the pearling day



gem experts, however, there are definite scientific tests by which the exact differences between genuine pearls and their simulations can be made a matter of preuse knowledge. These methods scientists have devised over a period of years, and all are now in more or less active use. Each procedure will now be considered a parately

One of the simplest methods of disinguishing between natural and socalled "cultured" pearls is the accurate determination of their specific gravity. The easiest means of making this test is by unmersing them in liquids of known density. The procedure usually consists of placing a pearl in a small container partially filled with acctylene tetrabromide, to which orthodichloroheuzene is added drop by drop until the pearl is in suspension, the density of the specimen and the liquid then may be considered identical

The specific gravity of the liquid is next obtained by means of the Westphal balance. The heaviest cultured pearl examined by the writer had a specific gravity of 2805; the lightest, 2715 Natural pearls have a lower specific gravity, averaging 2.685. The test, however, has its limitations

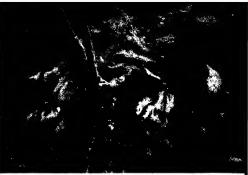
For the past 15 years, the X ray has been used to differentiate natural from cultured pearls. This procedure is accomplished by passing a narrow beam of X rays through a metallic lead pinhole



Natural nearl, of an unusual shape. showing concentric layers extending throughout. Photographed in polarized light. No nucleus present: central spot is an optical effect

camera" of proper thickness, having an outice 0.02 or 0.04 of an inch in diameter. The pearl to be tested is placed over the small opening through which the X-ray heam is to pass. If the gem is natural, a uniform scattering of the X rays takes place when they impinge, and, therefore, they will produce upon a photographic plate a six- or twelve-fold "spot" pattern. This characteristic pattern is caused by the regular concentric arrangement of the aragomite characteristic of natural salt water pearls.

A cultured pearl similarly tested, on



Pearl divers are rugged, with extraordinarily well-developed lungs. This man is ready to dive and holds the rope by which his partner, on deck, will pull him up from the depths

the other hand, will usually produce a maltese eross pattern, or modification thereof; this appearance is attributable to the peculiar parallel mineral arrangement found in all mother of pearl substance

Another ingenious method used to differentiate cultured pearls from the natural gens employs an "Endoscone," invented by Chilowsky and Perrin in 1926 Briefly, the apparatus consists of a carbon are a lens system, and a hollow hypodernic-like needle, at the tip of which are placed two platmum mirrors set at angles of 45 degrees and in opposite directions from one another.

As a typical natural pearl is composed of concentrically deposited aragonite throughout, and a cultured pearl has a large core that is distinctly layered, it is plant that light directed within such structures should react differently because of their physical differences, If a drilled natural salt-water pearl is placed on the hypodermic-like needle and then observed through the focusing eyepiece of the lens system, one finds that a flash is produced when the pearl is moved hack and forth over the needle after the are has started to burn. A similar test made on a cultured pearl will not reveal this flash. In the former case, the powerful beam of light traversing the needle is reflected from the first minute platinum mirror up to the pearl substance. Because the layers are concentrically arranged throughout, the light is totally reflected. On moving the pearl back and forth, the totally reflected light is "caught" or reflected on the second or outside mirror which constitutes the tip of the needle. The registered flash is seen in the eyepiece, A cultured pearl, having a large core composed of parallel layers, will not reflect light and, consequently, no flash is produced.

By this method only one drilled pearl

can be examined at a time. Furthermore, this test cannot be applied to undrilled

All mmeral matter is either diamagnetic or paramagnetic Knowledge of this physical property resulted in the invention of a new instrument by Dr. Richard Nacken, of Germany, in 1929. The structural differences in pearls mentioned in the preceding paragraph permits differcuttation by the use of this method. The test, however, is not as efficient as the endoscopic procedure, and is the least

FOR many generations distinguished families have considered pearls as heirloom gems, to be handed down from mother to daughter, usually on the wedding day. We have seen bow this linking of pearls with brides goes far back into history, beginning with early Indian legends. Like chests of silver, pearls never go out of style, nor does their value decrease with the generations.

There is a definite reason for this permanent value. Unlike other newels, there is no need for a 'world corner" on the pearl market. The number of really fine pearls brought up in any one year is definitely limited No great "find" disrupts the market, and it is never necessary to hold up part of any year's tuntuo

It may take years-in fact, it nearly always docs--to assemble a superb necklace. When, therefore, the pearls are finally brought together into a matched string, the achievement is eventful, and their value in this form is greater together than their combined separate cost

It is evident from what has been said that the popularity of the pearl is in no sense faddish. With 4000 years of admiration behind it, this beauteous geni may look forward to as many in the

Inside The Stars

S OME of the simplest-sounding questions are the hardest to answer. We know a good deal about the stars by this time—their distances, their motions, their real hightness, and, in many cases, their actual diameters, but it has taken a long time to answer, even in part, the obvious question, "Why ito the starssime?"

In one sense, the answer is easy enough. The stars shine because they are hot--very hot indeed, even in their outermost atmospheres. Unless the whole surface of a star is as hot as the hottest part of a blast furnace, it will not shine brightly enough to be visible at the enormous distances with which we have to deal. We can measure this surface temperature by incthods similar in principle to those which are used to find the temperature of an industrial furnace-by the intensity and color of the light which comes out through a hole in the door--and we find that, for a red star (cool as stars go) it is from 2000 to 3000 degrees, centigrade, The Sun's is 5700 degrees, and the figure rises to some 10,000 degrees for white stars like Sirius, over 20,000 degrees for the stars in Orion's belt, and perhaps 50,000 degrees for the very hottest stars,

We can calculate just how bright a star of given size and temperature will look at a distance of so many light-years, but this does not answer the question "What makes the stars so hot?" Here again we may "stall along" with a simple answer. The stars are hot outside because they are still hotter inside, and the heat leaks out to the surface. But the questioner might reply, "You can't get inside a star to find out about it, how do you know that it is hot inside?" And the answer comes: It has got to be enormously hot insidemillions of degrees-provided only that the matter of which it is composed is of the same nature as that which we can study in our laboratories, and there is plenty of good evidence to convince us that this is true.

From the Sun's gavarational attraction on the planets, we can find its total mass, and that its average density is 14 times that of water. Its attraction inpon its own outer layers produces an enormous internal pressure. If the density was the same at all points, the pressure at the center (as can easily be calculated) would be 98,000,000 tons per square inch.

It is no more than a high-school exercise to calculate how hot a mass of gas would be if this enormous pressure compressed it to no more than the given density—provided that one assumes that Why do the Stars Shine, How do We Know They Are So Exceedingly Hot inside, and What Makes them So? From Whence Comes their Vast Store of Energy?

By HENRY NORRIS RUSSELL, Ph.D. Chairman of the Department of Astronomy and Director of the Observatory at Princeton University Research Associate of the Mount Wilson Observatory of the Carnegic Institution of Washington

the familiar "gas laws" of the laboratory can be applied under those extreme conditions. If the gas was hydrogen (loose atoms, not molecules) the temperature

would be 11,500,000 degrees, centigrade. It is of course practically certain that the density is greater at the center than the average, and probable that it is much greater, and to get an exact value we would have to know just how the density varied at different distances from the center. But to increase the central density means to bring the material nearer the center, and give gravity a more powerful hold on it, and this increases the pressure Calculations made for different "models" show that these two changes nearly compensate one another. For example, a density-model which Eddington has made famous has a central density 54 times the mean; the pressure is increased 92 times, but the ratio of the two, and hence the temperature, is increased only in the ratio 170. Another model, recently calculated by Chandrasekhar, makes the central density 88 times and the pressure 171 times the values first considered; the factor for the temperature is 195,

THE temperature at the Sun's center, on these two models, comes out 19, 600,000 degrees and 22,400,000 degrees—provided that the gas consusts of hydrogen atoms. There is good reason to believe that these 'models' represent, in a general way, the internal structure of many (perhaps not all) of the stars.

But, on the rudimentary theory, this temperature should be proportional to the atomic weight of the material. If it was iron, the value would be 56 times or as great, or more than a billion degrees! Our calculations of temperature, then, depend far more upon what we suppose the Sun to be made of, than upon what pattern of internal density we assume.

Until about 15 years ago, no one would have dared to take this calculation very seriously. It seemed more likely that the atoms would be jammed together so tightly, by a much smaller pressure, that

no mercase could squeeze them into a much smaller space. If the atoms were rigid bodies, this might be nearly true, but as their properties became better known, it was realized that their outer layers of electrons would be shelled off and left to wander freely, leaving cores so small that the whole affair could be condensed to a very small volume. The only way to escape this, inside the Sun, is to have the particles moving about so fast that their collisions keen them from being sammed closer-and this is only a way of saying, in other language, that the material as a whole behaves like a very hot gas. So the simple calculations are good after all.

How hot the gas must be, to stand the pressure with the given density, depends on how many moving particles there are in ti-some cach, on the average, will have the same energy of motion. If they were all atoms of iron, which weigh 56 times as much as hydrogen atoms, the temperature would come out 56 times as high. But an iron atom has 26 electronious die its nucleus, and, if these are all knocked off, the energy will be divided among 27 particles and the average amount, and hence the temperature of the gas, will be correspondingly lower.

This is a very fortunate thing for our calculations, for no matter with what sort of atom we start, the average weight of the pieces will be nearly the same. For sodium, for example (weight 23, 11 electrons) it is 1.92; for oxygen (weight 16, eight electrons) it is 1.78.

The calculated temperature inside the Sun threefore depends very luttle spon the chemical composition—with two important exceptions. A helium atom (weight 4, with two electrons) gives an average weight of 1.23 per piece, and a hydrogen atom, breaking into two parts, a weight of only 0.5.

For a star of the Sun's size and mass, built on Eddington's model, and composed entirely of hydrogen, the central temperature would (in round numbers) be 10,000,000 degrees, if it was all hehum, 26,000,000 degrees, and, if all of heavy atoms, about 40,000,000 degrees. Chandrasekhar's model makes the temperature 15 percent higher—a small difference compared with the effect of the

atomic composition. When we compare one star with another, we find that, for those huilt on the same model and of the same stuff, the temperatures at the centers (or any corresponding points) should be proportional to the mass divided by the radius For Sirius, for example, the mass is 24 times the Sun's, and the radius 1.8 times, so that the central temperature should be about 30 percent higher than for the Sun. The most massive star for which we have accurate data is 29 Canis Majoris an eclipsing system, in which the larger star has 46 times the Sun's mass, and 20 times its radius; its internal temperature should be therefore a little more than twice the Sun's. At the other end of the list of well determined systems is the faint companion of Castor-also an cohpsing pair, composed of two stars having 63 and 57 percent of the Sun's mass, and 66 and 60 percent of its diameter The central temperature for both comes out 95 percent of the Sun's

These stars all belong to the great main sequence which runs from faint. small, red stars of small mass to brilhant, large, massive white stars. For these, except for the higgest and hottest, the internal temperature should be much the same as for the Sun (which belongs to this sequence). Some stars, howcver, are quite different. For Capella, with 4.2 times the Sun's mass and 16 times its diameter, the internal temperatme--other things being equal--should be a quarter of the Sun's, and for the great red giant Zeta Aurigae (niass 15. radius about 200) it should be only 7 percent of the solar value. Even thus, lowever, is more than a million degrees (unless we assume that the star is made up almost entirely of hydrogen).

To get a closer estimate of the internal temperature of a star, we must insome way be able to find out how much hydrogen and helium there is inside it. This looks like an impossible task; but there is a way to attempt it.

The rate of leakage—or flow—of heat in from the hot interior of a star to the surface must evidently be just equal to the rate at which heat escape from this surface into space. We know this for a great many stars. Allowance must be made for the heat which escapes in the form of missible infrared or ultraviolet radiation, but this is easy except for the hottest and the coolest stars.

Now the rate at which heat will flow through the stellar gas—for a temperature gradient of so many degrees per mile—can be calculated. Under ordinary stellar conditions, this heat is almost entirely carried by radiation—sent out

from one atom, caught by another, relayed again to a third, sometimes outward, sometimes inward, but working gradually toward the surface. We know enough about the properties of atoms now to permit a rather accurate calculation of the net rate at which heat will flow (if we know the temperature, pressure, and composition of the gas). Applying these principles to the stars (as was first done by Eddington, years ago) it is found that the net rate of supply of heat from the interior to the surface depends mainly on a star's mass-increasing very rapidly with this-but surprisingly little on its radius or its internal density-model. This explanation of the observed relation between mass and luminosity was the first great triumph of the theory of stellar constitution.

But the same theory indicates that the star's luminosity should be greatly influenced by the composition of its interior. If this consists entirely of heavy elements, the central temperature will be high, and the temperature gradient to the surface steep This greatly increases the heatflow, so that such a star will be bright. The more hydrogen there is in the nux ture, the lower will be the internal temperature and gradient. At the same time, the onacity of the gas-the resistance it offers to the heat-flow--will be less, but the first effect is the greater, and the calculated brightness dimunishes. It is thus possible to calculate, from our knowledge of the properties of atoms alone, just how much heat a star of a given size and mass should radiate given the "model" on which it is built, and the percentage of hydrogen in it When these calculations are performed for the Sun (using Eddington's "standard" model of density distribution) it is found that a star with no hydrogen comes out much too bright, one with a great deal is much too faint: while one with 36 percent of hydrogen, by weight-and the rest heavy atoms-matches the Sun exactly On this basis the mean weight per particle is 0.98, and the central temperature close to 20,000,000 degrees.

The calculated brightness, and the deduced hydrogen percentage, like the central temperature, are not much changed by reasonable alterations in the assumed density-model

assumed density-model! If helium is prevent as well as hydrogen, other solutions are possible. For example, Stringern (to whom these calculations are due) finds a solution for the Sun with 60 percent hydrogen, 36 percent helium, and 4 percent heavy atoms. This makes the mean weight of a particle 0.67, and the central temperature 13,000,000 degrees. This series of possible solutions ends with one containing 99.8 percent hydrogen, and with a central temperature of 10,000,000 degrees. Stringere finds, by this method, very nearly the same composition for most of the stars for which there are re-

liable data. For example, Strius (the bright component of the bunary comes out with 36 percent of hydrogen, Capella with 29 percent, if there is no helium present, and the other solutions are also similar. A few stars show evidence of different composition. For example, Zeta Hercults, which is four times as bright as the Sun, though of almost the same mass and surface temperature, gives only II percent of hydrogen; and some of the lot stars at the top of the main sequence come out with 50 percent or more.

It is not surprising to find that most of the stars are similar in composition, for it seems reasonable—though we cannot prove it—to assume that they were somehow formed out of the same material.

The atmospheres of the stars, which we can study directly with the spectroscope, are actually very similar in composition, barring the effects of different temperatures in "stirring up" the atoms. In a few stars there appears to be an excess of silicon, or strontium, or barium. There is far more hydrogen than in the interior. Rosseland has explained this. The free electrons, which are very light, tend to rise to great heights. To prevent this, there must be a small electric field pulling them down and the charged atoms up. The electric force will have more effect on the light hydrogen ions than on heavier ones, and so will draw hydrogen toward the surface

BUT the greatest question of all restars shining ' At the end of the last cen tury we thought we knew Helmholtz and Kelvin, a generation carlier, had shown that, if the Sun, or any other star, contracted slowly, its gravitational energy would be gradually converted into heat Half this heat, and in some circumstances more, would be required to raise the temperature of the interior (which is mereased by the contraction) but the loss by leakage to the surface, and radiation into space. The star would automatically adjust its rate of shrinkage to the right amount to meet the annual radiation, and so keep shining for a long time. Applied to the Sun, this theory accounted for about 15,000,000 years shining, at the present rate, before it got to its present size. In those days, that seemed an impressively long time. But there is now conclusive radioactive evidence that geological time has involved fully a hundred times as long as this, and that the Sun has been warming the Earth very much as at present all this while. Whence has this enormous source of energy been derived?

For the first time, a reasonably complete and satisfactory answer has been given to this question: but we must wait till next month for space to describe this.—Princeton University Observatory, March 4, 1039.

More Water for Niagara

NIAGARA FALLS can be sat guarded against serious self impairment as a spectacle. How this can be done has received, here shown by work carried out in the upper rapids of the more. This should be welcome towes to the many millions of people that consider the falls to be the greatest of our natural wonders. Once more the engineer has won his battle describe rare a form of the process of the proc

Every now and then large masses of tock detach themselves from the crest lines of the two falls, and immediately there is excited elamor that one or the other of the two cascades is

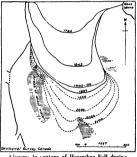
committing suicide." If such were, indeed, the fact, then the falls have been busy at their own destruction ever since they started upon their stupendous recession some 35,000 years ago at the oug mal escarpinent, seven miles downstream from the present site What is the print significance of a few thousand tons of detached rock compared with the meone wahly great volume of rock that the niver has canved out of the varied formations in the period mentioned while erading a gorge mile- long, from 200 to 300 feet deep, and of varying but extensive width? Each mass of rock so released is merely a recurrent comundar of the tireless forces that have been at work duiing past millenia and will continue for ages to come,

The earliest record of the contour of the Canadian or thorse-she Fall, which has been altered by crosson in latter decades more than the American Fall, dates from 1764, and at subsequent intervals the crest line has been observed and registered by drawings. These records disclose that the Horses-hoe Fall has undergone considerable change of crest line in the course of the last 200 or 300 years, but none as, relatively-picking, scarcely more than an inconsignent nibble compared with the modifications that have takin place in the

The Niagara River, in its approach to the two cascades, flows over a thick stratum of rock which is a hard limestone formation and highly resistant to erosive action. The river level drops about 50 feet to the mile as it descends to the falls, and because of the swiftly Weir Raises Water Level in Power Plant Forebay
. . . Incidentally Spreads Water Over Falls . . .
Enhances Speciacle . . . Unique Problems Solved

B. R. G. SKERBETT

moving water, the lip of the Horseshor Fall is ceaselessly exposed to ensire action. As a consequence, the recession of the crest line, due to this wear, had been found to be as much as 4.2 feet in a sin-



Changes in contour of Horseshoe Fall during the years from 176t, and predicted changes

gle year; and hetween 1842 and 1927, the mean annual tate of recession is known to have been 37 feet. Since 1905, however, the mean recession has been 2.3 feet. The less-ruing of the retrogate movement is largely the result of a reduction in the volume of water pouring over the falls, due partly to the duersion of water for power.

purposes at points upstream Even though natural forces are inevitably bound to continue their erosive work at both the American Fall and the Canadian Fall, and recesion will persist until Niagara-Falls opens the flood gates of Lake Erie thousands and thousands of years hence, it is still practicable, as has been proved lately, to direct the flow of the water at the falls in such a manner as to modify its erosive action. It is also possible to bring about a better balanced distribution of the water throughout the critisecep of the creed line of each fall. Improvement in the entire spectacle may come by achieved with a lesser volume of water than ordinarily passes over the falls.

These betterments were indicated assistible in a report made about eight years ago by a joint international horal composed of emmort Americans and Ganadians. The board disclosed that competent eigeneess were satisfied that errosion could be reduced and the picture-spieness of the falls enhanced by controlling the flow of the water to the cast ades through the medium of submerged were, but nothing to that can was done at the time by either interested matter Samething now has been done, and the Horseshoe Fall has gained in beauty in consequence.

The international report to which reference has been made stated that more water could be diverted for power purposes yet still leave an ample volume to maintain the fulls in their prime as a



Vertical section of the falls showing the various strata. All slope downward to left, upstream

spectacle, This is a matter of importance because the Niagara River has become a source of indespensable electric energy for nearby communities and essential indistributed in the state of the state of the internal activities. It is a fact, however, that a condition of lowered water in the internal manufacture of the state of the has brought about the building of a stanarged went that incidentally has beine fited the Horses-hoe Fall, Primarily, the went has been constructed to restore to one of the Canadan power plants the colume of water that it had at it disposal who is first put in operation 35 vents ago.

During the succeeding three and a half decades, the level of the river dropped because of much dimurshed, candall, over a protacted period, throughout the expansive water-lied of the Great Lakes Also, the Chicago Dannage Canal, the improved Welland Canal, and the New York State Barg Canal have made in reased darks on the waters of those lakes, Furthermore, expanding power plants, with their intakes

above the falls, have withdrawn more water from the river to meet the demand for larger blocks of electric encigy To satisfy their customers, power companies have successively amplified the capacities of their station- In 1904, the total installed capacity at the Niagara Falls stations was but 122 750 horsepower Today, it is 1563,700 horsepower The lowering of the river level became particularly serious for the Canadian Niagara Power Company, Ltd. To re establish the water level in the forebay of its plant, located about a third of a unle above the Horseshor Fall, that company, with the full approval of the authori-

ties, récently has built a subaqueouwen about 930 feet long that extendfrom the Canadian shore obliquely upsteam. It reaches out against the sweep of the river like the furearm of a semimer, with a curved elbow where the structure is tied to the shore at the down stream side of the forebay entrance.

The weirs proposed ten years ago were to be rockfull structures. The wen that now serves the plant of the Candan Nuagara Tower Company, Ltd., is of concrete of a superior character. The structure is designed to be permanent and capable of meeting the most rigorous conditions, its construction called for unusual precutions and engineering expedients. The work necessitated the construction of a temporary operating pier of the same length as the concrete went; and along the downstream side of the pier was successively formed a cofferdam of sufficient length to norm! the



Above. Temporary construction pier that was the base of operations. Below: One of the cells being made ready to be swing outboard and lowered into position



pouring of the wen in a 72-foot section each time—the cofferdam being unwatered so that the concrete could be placed in the dry and handled in a manner that would make certain of highgrade workmanship throughout.

Although the original design of the weir was planned broadly to meet conditions under water as they were largely assumed to be, nevertheless provision had to be made for modifications as more exact knowledge of the river was obtained during the building of the temporary pier. That pier, besides affording a working platform and creating an area of relatively quiet water along its downstream side, was also to serve experimentally as a weir and, by means of various tests, to disclose just how high and how long the permanent weir would have to be to raise the water in the forebay of the power plant to the level that had existed when that station began operating and withdrawing water in 1904 It was essential that the weir should not be visible or detract from the natural beauty of the rapids above the fall. No exact soundings had been made proviously along the line chosen for the weir The swiftly inning river and the nearness of the fall had made such work not alone too hazardons but too costly Therefore, the construction of the pier was, in itself, both a venture some and exploratory undertaking, and it was counted upon to reveal, as it advanced ontward, the changing depth of water and the varying features of the rocky river hed. The procedure was more or less like wading into a treacherous stream with the prospect of a sudden and perhaps dangerous drop at any mo ment

The pier was made up of numerous unit cells fashioned of structural steel and having the form of four legged rectangular frames, which were assembled on shore and set upon the river bed, one by one, as the pier was extended oblique ly outward from the shore, Each of the four legs was a heavy I beam, and the lower part of each leg was shortened, when necessary, to conform to the river bed To give the cells a better and a uniform footing, each leg had welded to it a sturdy cast-steel spiked shoe, added after any excess length of the corner legs was burned off. In the upper section of each cell there was a timber haed bin capable of holding 50 cubic yards of gravel ballast that was added each time after a cell was in its assigned place in the pier. To stabilize the pier further, each leg of each cell was anchored to the river bed by two two-mch steel dowels that were driven into holes drilled into the rock beneath each leg after the cell had been set. Before a cell was lowered



Within an unwatered length of cofferdam, beside sheltered flank of pier, while wooden forms were being ejected to pour a 72-foot length of submerged weir

mto place, preses soundings were made where the four legs of the next cell to be lowered would rest and the lottom was cleared of all loose material to assure a footing on firm rock. The soundings were nade from a platform cantilevered out from the last cell in position. In this manner, the pier was knightened cell by cell after deliberate and careful preparation; and in the end the pier was composed of 51 c ils

EACH cell had a width of 12 feet and a length of 24 feet, and the cells were arranged with their length across the axis of the pier There was a gap of six feet between succeeding cells and there was a free space of 12 feet or so between the under side of each ballast bin and the bed of the river. The gaps between the cells and the spaces below the bins could be closed when or where desired by stop logs--rectangular timbers-dropped into place between the flanges of the upstream legs of the cells This provision made it possible to obstruct the flow of water through the pier structure and permit it to function as a werr of variable height. In this way, the engineers were able to ascertain how long and how high the permanent weir should be to raise the water in the forebay to the required level. The six foot gaps between the cells were designed to provide ready passages for floating ice so that the obstruction would not cause an ice jam that would be almost certain to shut down the power station, for the work had to go on throughout the winter.

On top of the cells of the pier were laid timber stringers, crossites, and the rails for two tracks—one for a large

the cells and do other heavy work in connection with the actual construction of the weir and the erection of the paralleling cofferdam, and the second, a narrow-gage track over which were hauled carloads of concrete and other materials. The pier was extended until it was made up of 45 cells, after which stop logs were put in place and the pier was used as a weir experimentally for several weeks. After continuous observation, the engineers decided to lengthen the pier by six more cells; and when so completed and with stop logs installed. it was found that the river flowed over the makeshift weir at a level of five feet higher than on the downstream side of that barrier. To deflect to midstream the violently eddying water at the outer end of the pier, there was suspended there a cantilevered frame of steel and timber having a length of 48 feet, This served its purpose, and protected from any troublesome disturbance the area in which the weir was to be built,

locomotive crane which helped to handle

in which the weir was to be built. The building of the weir started at the outer end of the pier and was gradually lengthened until its inner curved section met the slure. The collection within which the weir was reared was formed of a series of steel frames around which water-tight walls were made up of interlocking steel sheet piling—the modern properties of the piling that were the steel piling that we have the piling that we have the piling that the pili

purpose, four sections of cofferdam, 96 feet long, served successively for placing concrete in a unit 22-foot length of weir; and the shoreward fourth section, at the conclusion of one such operation, was left in place to form the outcame part of the next unwatered length of cofferdam within which would be poured the succeeding 27 feet of weir. Beside-cleaning the river hed to expose sound to the concrete, the weir was further anchored to the basic rock by means of two lines of livary steel dowels driven into the rock and projecting above it.

Despite the bazardous conditions surounding the entire job, the work was carried forward to completion with but a single unexpected setback, which occurred where the project crossed diagonally an eroded channel 12 feet deep and 60 feet wide that was filled with a tightly packed mass of gravel and boulders. This was not serious. When the work was finished approximately \$435,000 had been expended. The depth of water in which the weir was built varies from 12 to 22 feet Work on the project was carried on for more than a year as the pier and the well were constructed and then the former was removed.

WITH the temporary pier and all sections of the cofferdam dismantled and removed, the only evidence of the subaqueous weir is a long line of tumbling water that is much like the other turbulent areas of the rapids where the river rushes downward over hidden reefs. Aside from restoring the original water level within the forebay of the power station, the weir causes the water near the shore end of the structure to continue onward to the Table Rock flank of the Horseshoe Fall and to provide a better distribution of the water at that point. It thus adds to the beauty of that cascade where the lowered river had exposed a considerable expanse of tock contiguous to the crest line.

The were has demonstrated how other may be constructed how other may be constructed from the first has been as the constructed from the first has been as a navelenspiring spectacle. In short, higgars Falls can, in a measure, be saved from self-defacement, thanks to the cunning of the modern engineer and to his associate, the well equipped and resourceful builder.

Or. Oscar Parkes, the noted naval authority, throws light on the puzzle of naval rearmament of the naval powers in two long articles that are coming soon, As usual, he made the dragings.—The Editor.

COMFORT COOLING

N aluminum-foil-coated operating room in Blodgett Memorial Hospi tal, Grand Rapids, Michigan, may hold the answer to science's long scarch for an ideal climate. In this unique room, air temperatures may be maintained as high as 90 degrees or above, with aver age humidity, without any perceptible discomfort to occupants, This amazing set of conditions has been made possible by an important development of Di. Clarence A. Mills, professor of experimental medicine at the University of Cincinnati, and may bring about new economies in building insulation and cooling and heating through control of human comfort by radiant nican-

The Blodgett installation represents and JO years of research on this new type of climate control. D. Mills spent about two years in actual testing at the University of Cincinnati with aluminium fold-lined compartments before the system was given its first patienal test in the liboqual. The Blodgett operating from his been serviced by D. Millsheat-control system for several summer months, and during this time, the installation has demonstrated highly encouraging results.

The Mills system is a departure from the conventional types of heat control now in commercial and home use, which depend mainly upon transfer of heat by convection and conduction, in that it mo Significant New System . . . Proved by Hospital Tests . . . No Costly Equipment . . . Employs Body-Radiation Reflectors, Absorbers . . . Cools No Air

motes the control of body heat by radiation. As most persons know, radiation is the transfer of heat between bodies of desimilar temperatures which are separated from each other by an appreciable distance. The heat rays proceed through it and travel with the speed of light. In a highly heated room, for example, a rhosed window, chilled by the outside an, will rapidly abort the heat radiationfrom a person's body standing close to at, with the result that the person will feel incomfortably cold in spite of the high temperature of the surrounding air.

In the Blodgett operating room, the addunt leaf from persons in the room passes to the walls, which are covered with enhoseed alimnium foil. The aliminum foil is highly reflective to these heat rays and low in heat radiation and in absorption. These properties, comined with the diffusing effect of the emloseed pattern, cause the rays to be reflected at contiles singles, perhaps many times, so that the majority of the heat rays trad to come into contact, somer or later, with two black wall-panels, approximately three feet wide by 15 feet long, in which circulating fluid has lowered the temperature to 50 degrees or under. These panels absorb the heat rays as a blotter takes up ink,

One of the beneficial features of this method of Ino-pital "comfort cooling" is the fact that the installation controls the room climate without changing the surrounding air, thus climinating indesired drafts during surgical operations.

THERE is no substant of thermal skin shock when entering the room from an unconditioned atmosphere. In spite of the high temperature of the room and the fact that heavy appared such as heavy duck gown, rubber gloves, hat, and make is wornt during an operation, profuse perspiration of the occupants is climinated.

Although the Blodgett installation is personal to conflort under light tem perature conditions stick as are necessary in operating rooms, tests have shown that, with slightly modified designs, the process can also be effected by the process can also be effected in the process. The process of the process can be presented by the process of the process

low temperatures also feel comfortable. Attention was first called to the Milsmethod of heat control at the meeting of the American College of Surgeons in Toomto in 1937 where it was brought not that D. Mills had made this novel approach to comfort cooling. As a result of the meeting, Dr. John F. Goriell, Director of the Blodgett Memorial Hospital programs interested in a practical application of this new comfort-conditioning for hospital operating rooms.

Although Dr. Mills' development has many proved possibilities, the inventor contends that there are several features which will probably have to be improved before a desired degree of perfection is obtained. When this point is reached, the equipment will function efficiently for both home and commercial use, Dr. Mills believes.

In a comparison of costs hetween the new theory and present-day air-conditioning systems, Dr. Mills and impartial engineers have computed the operating expense at from one third to one fifth that of air-conditioning equipment of similar capacities.



Temperatures of 90 degrees and above are comfortable because the body's heat, radiated to the aluminum walls, is reflected to the cool heat-absorber (black)



Photograph contest U. 8. Forcet Scribe Portable tie mill cuts 300 ties daily, the product of four men. Such mills can be set up at the timber source, eliminating long hauls



Some tracks carry their trailers into the forest where, hooked together



Photo, uph control U. 8. Frest Sertic In some cases lumber floats down man-made rivers or flumes to a loading point on a railized or a rive Belaw. A tower skidder does not sequire a tree at the tracks; a steel spar is mounted on the machine those, protection of the processing of the protection of the processing of the processing the protection of the processing of the protection of



Among new machines in the forests is this combination hulldozer and firefighting pump. Two overhead steel tubes protect the driver against branches

Flexible Power

STANDING sturder than the proverbul oak, the head of a tall steel-panrears above a Washington lagging camp; across canjons, strong cubles skid to the side of the spar leavy logs which yesterday were 200-year-old trees in a carby Oregon forest a portable tie mill salvages second-growth timber, Douglas fire too small for the big utilitie to fell.

These two tumber-handlers represent the change in forest machinery which is witnessing the disappearance of big, costly milk and the evolution of power units with which small operators penetrate the forests, logging small areas which formerly were not touched.

Nick Meyer, for example, operates a four-man te mill near Lapine. Oregon, cutting 300 railroad ties daily, the product of a faller, sawyer, offbearer, and stacker. He moves through second-growth tumber, some of which is less than a half-century old, cleaning up odd corners passed by former logging outfits.

Els-where through the northwest, other novel mechane speed the cutting of merchantable tumber. Saws, powered by electrony which turns endless chains, bute through the wood, felling texes in jut men. Dissel engines in mul tiple tunis, gasoline motors, and steam ragness bring the big tumbers to trail and water. Lumber, rough cut at mills deep in the woods, foats down man-made rivers to shipping points. From the moment a lumberpack abouts, "Timb-a-t-T Timber down the hill," to warm all while hearing that a tree is falling, fast, mobile markines take up the job of rushmight to distant markets.

Standing on a railroad car bearing a stram-engine and winches into a Weyer-hauser forest, the steel spar and skidder may be moved all along the line, pulling logs through the air from cutting areas a half-mile distant. The skidder system is the method commonly used for gathering in logs on large cuttings.





Loaded logging truck and Diesel converted shovel loader handling ponderosa pine logs in an Oregon forest



Less than three feet wide, this baby bulldozer-tractor builds trails in mountainous country that larger units may follow



Procograph contry U 8 Forcet Service

Recommendate This is a combinet
frequently seen near the forcets. Trailer-trucks are used for longer h

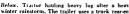
IN THE $\overline{ ext{Woods}}$

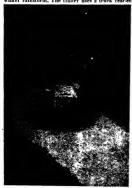
It involves use of a skyline, or two inch cable suspended between two supports. Along the skyline rides a steel carriage weighing nearly as much as a small automobile, to which are attached hooks for picking up one end of the logs. Back and forth noves the carriage, skidding logs to the landing

HIVE years ago most tumber wached the shipping points on aniroads, built by loggers deep into the forests. Loggers recently have patterned their operations after the construction industry. Now, logs by tens of thousands are lifted by cables and towed through mad and snow on tractortype trailers, or ride over solid truck tures and truck differential housings to forest roads cut by shape-edged buildozers. Only recently there appeared in Oregon two such machines built by the U. S. Forest Service, one a baby scarcely three feet wide, the other a sonorting giant capable of building several

unles of six-foot road between breakfast and dinner. By swinging two levers, the operator can convert this machine into either a water pump or an oil pump, for fighting fires or setting backfires when a logging camp is threatened.

Unable to turn around on the narrow roads, trucks carry eight-wheel trailers on their backs to the loading points. There other machines pick up the trailers and set them down in the roadway. After the units are booked together, heavy loads of logs are piled on for the rough journey out of the forest. Few of these are one-purpose machines. Diesel shovels may be excavating for a road today, loading logs tomorrow. Locomotive cranes, powered by steam, lift logs or right ears over-turned in a wreck. Hundred ton locomotives are passing, for each piece of today's forest machinery must be capable of handling several jobs to keep up the accelerating pace of logging - Indrew R. Boone.







MONTHLY DIGEST

STOPPING THE MARINE BORER

PROTECTION against the ravages of the marine borers on wharf pring in all but tropical waters is now offered by a unique type of shield with an estimated life of a least 15 years. Cost of mistalling the shield

Applying a small section of wood en shield to stop marine borers

varies according to territory, but in no case does it exceed 50 percent of the replacement cost of the piling, according to its producers and INCO magazine

Since almost all marine borers attack what piling between the mid-line and the how-water mark, the sheld is designed to cover this section only Length can be varied in accordance with the demands of local conditions.

Essentially, the shorld converts of a wooden casing treated to absolute refusal with crossite. After being applied, the casing is then filled with sand A patented device at the base of the shield prevents the escape of sand after installation and aids in ceutering the shield around the pile.

The base is made up of 12 staves approximately 15 inches long, fastened in two semicircular sections lunged together. This base is applied around the pile above the water line and the two semi-circular sections are bound together with a Monel wire hoop and Monel clip assembly. The base is their forced down as other sections of staves are added.

The section staves, each provided with internal and external members to engage the top of the corresponding stave below, vary

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN

charge. Daniel Gussenheim

n charge, Daniel Guggenheim School f Aeronautics, New York University D. H. KILLEFFER Chemical Engineer

How marine borers destroyed a yellow-pine pile that was unprotected

in length from two to five feet. They are likewise bound together at intervals with Monel hoops.

The completed shield is forced down until it rests upon the bottom. Upon being filled with sand it will sink into the mud to depths varying from four to 15 inches.

depths varying from four to 15 inches.

The value of the sand as a protection medium has been definitely proved by the examination of samples taken from piles at

one-host intersals and examined microscopically, both before the shoeld was erected and filted with said was filted with said and after the shorld was recommended by the said was said to be said to the said to be said to

Known as the Upton Pile Shield, the device is produced by Anderson Products, Inc.

TRUNK-SIZE

REFRIGERATED CONTAINER

SMALL-LOT shipmens of quick-from a flood hold, and the solid policy and products, fight, flowers, and all types of perturbalies will be further, and the solid perturbalies will be further of by a new type container manufactured by General Electric and recently put into general new by Railway Express Agency. The container, neveral years in development, was designed in dependently by Mayou Elihi Church and is heralded as the perfect soil to the problem of making less-shancer-load shipments of pervisable goods which must be kept at low temperature of the problem of the problem of the solid periods of the problem of t

The container is about the size of a large trunk. Its 10 cubic-foot storage space provides a cargo capacity for 300 to 400 pounds of food; and, in addition, the ice bunker



For small-lot shipments

will hold 100 pounds of dry ice, or 90 pounds of water ice, Total weight of the container, loaded and ready for shipment, is about 650 pounds.

Preliminary tests indicate that a charge of 100 pounds of dry new till prutect a shipment for more than 72 hours in average outside temperatures of 90 degrees. It was pointed out that at this rate of consumption, the refrigerant for the container in one shipmen in would cool but two-and-a-half cents an

In addition to expanding the market for perishable food, the new container will facilitate quick transportation of biological materials requiring low temperatures in slipment

"LOOK WHERE YOU'RE GOING"

DEATHS from motor vehicle collisions with fixed objects have increased more rapidly than any other type of motor fatality—244 percent from 1927 to 1937.

-Highway Research Abstracts

AERO-THREAD SCREW

THREAD

MAKING use of a new system of application, the "Acro Thicad" seriew thread system is meeting with wide interest from manufacturers and industrial concerns, particularly for those applications where the maximum rehability in screw fastenings is required.

This system was developed primarily for one in the aircraft industry where high strength stude and copy-riess, are required it has particular advantages for series that fastes mite tapped holes in light alloys such as those of aluminum or magnesium. Because of the especially high strength that can be obtained from an Aero-Thired series or stud, this series system is attractive for use in all machinery where compactness and high weight are desirable.

in the against our desirate of the Artilational desiration in the two of a spirally wound insert or inclung of previous formed, high revise, hourse apring were. This users this into the tapped hole by screwing into the threads and the design of the meer is such that, while it can readily be served into place, when once it is installed it becomes a fixed part of the tapped hole. When the stud or cap sterve is sassembled, its bearing is, therefore, against and in direct contact with the hard sparal bronze interr-instead of



The threeson, \$2 inch Prex; telescope mirror for the M.Donald Observatory, seroal largest in the world and the most accurate mirror ever tested, was wrapped in Cellophane for alignment from the Warner & Swasey Co., in Cleve-land, to Mi. Locke, in western Traxs, Cellophane was chosen because it is non-porous, and would not collect mosture during the trap. If oil or wax paper were used, there would be danger of getting spots on the mirror, which would have to be polsabed off. Even if the Cellophane touches the pulsabed surface of the mirror, there is no possibility of spotting The covering also keeps out all dosts.

against the soften metal of the light allow pair. The thread to the Actor-Thread study and cap series is of a shallow rounded form, the soften are study of the metal. The complete chammation of all sharp corners in the thread on the study of cap series allows the use of study and series heat-treated to high values of trassless trength, and these seriess have very much greater, shock resistance and furgion that the study of the stu

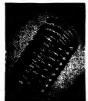
Threads system simplifies the STUKING of study and screws. It protects the threads in the female parts from wear and damag and thereby eliminates the need for oversized screws and study, or for re-tapping the holes when replacements are necessary. When an Acto-Thread study or ap screw is temoved from the tapped hole, it is generally

found that it can be it placed with one of the same size and still maintain the original designed thread fit. If the insert should become damaged or worn, it can readily be replaced with a new insert and the threaddlode will be brought back to its original dimensions.

The Acro-Thread system also allows—for the first time—the untestricted use of cap screws and removable screw fastenings in the light alloys of aluminum or magnessium, as the insert fully protects the soft threads in the tapped hole and its anti-frictional property allows smooth, non-wearing, and property allows smooth, non-wearing, and

FROST IN THE BAKERY

Q UCK freezing is expected to help bakers solve their most vexing problem, that of too quick staling of bread Recent investigations have shown that bread can be kept fresh if it is frozen and stored at low temperature as soon as it is baked. Experts were









The new Acro-Thread screw thread system described above, and how it is applied



LZ 130 during a test flight. Below. A view down one of the cat-walks, showing typical construction of the air-hip, and the auxiliary rudder-control station

made to distinguish any difference between freshly baked loaves and others that had been stared for as long as 20 days at 31 degress. Fallienheit Leen after nearly four months hir ad kept at this low temperature was quite salable Possibly bakers may now add low temperature cold stores to their plants to help take in plack between production and demand

Within recent years, important progress has been made by back is toward a bof which keeps better and methods of wrapping and keeping fread fresh longer. However, note of these has prouded for su long or so satisfactory keeping as quick freezing. The temperature used is lower than any met commercially except in modern quick freezing practice $\sim D$ II K.

DIVES

TSHEORETICALLY, engineer-say, there is no limit to the maximum dwing speed of planes under test, and they believe the record of On unles an hour, set by Leutenant Troy Keith, of the Au Corps, may be surposed, Palling out at dive is the difficult thing for the plot, for he can withstand a strain of lig for only about a fifth of a second

To Follow the "Hindenburg"

NDETERRED by the terrible disaster of the Hindenburg, the German Luftschiffban Zeppehn has completed and successfully tested the LZ 130, which is the 119th large rigid air-lip built by this company (eleven others were designed but bever built). Basically, the design is very sundar to that of the Hindenburg, although many refinements have been incorporated The length of the new airship is 803 feet, and its maximum ibameter is 135 feet, giving a fineness ratio of 6 to 1. The lifting gas capacity exceeds 7,000,000 cubic feet. The 16 gas cells were to be filled with helium, but the controversy with Secretary Ickes makes it rather doubtful that the German company will be able to obtain this valuable non or flanimable gas from the United States

The passengers in the LZ 110 will be



housed within the hull in 20 cabins luxurous enough to stand comparison with the accommodation offerd on modern ocean liners in the construction of the firmture, duralmum has largely been used in place of wood, as a finith; weight saving measure, holes are punched into the metal ribs and braces of the formure.

Compared with the airship the airplane is childlike in its samplency. The structure of an airship is an engineering problem of enormous complexity. The structure of the LZ 1/0 is of the classical type with 36 longitudinal griders and wire-braced frames at intrivals to house the gas cells and reinforce the longitudinals.

Some curious statistics are supplied to us by the Luftschiffhau Zeppelin The total length of frame girders is about 14 miles, the number of rivets used is 5,500,000, the total length of steel wire used is about 80 miles. and the area of cotton material for the onter cover is about 33,000 square yards. Four Daumler-Benz water-cooled Diesel engines, of 800 to 1000 horsepower each, supply the power The Diesel, with its great reliability, is the logical power plant for the airship where weight of engines is not quite of the same consequence as in the airplane One of on photographs shows the LZ 1.30 in flight. Another photograph illustrates typical cor struction, showing the interior of the keel and the auxiliary rudder-control station.

It is sometimes believed that all airship work in the United States has ceased and that Germany alone is active in this field. A symposium on airships held at the Annual Meeting of the Institute of Aeronautical Sci-

ences belies this pessimistic view. Thus, the Navy has recently received a 400,000 cubicfoot non-rigid air-hip or "blimp." In the field of large airships, Congress has authorized the construction of a right airship of only 1,000,000 cubic feet to be used for training and research purposes Dr. W F. Durand, Chairman of the Special Committee on Air ships, speaking at the above mentioned sym posium, pointed out that since the great disasters to the Akron and the Macon, an immense amount of structural, aerodynamic. and wind tunnel research has been carried out, which has filled up many gaps in our knowledge Dr. Durand expressed his viewas follows. "In our opinion, we are now in a position to design and construct airships with an assured margin of safety abundantly adequate to justify continued construction

FLIGHT BY WOMAN

WELL known engmost of Philadel pina, Enea Bosso, has built the 'Acro-vele" which has been flown for three quar-(vel ters of a nule with all the power supplied to the propeller of the very light monoplane by the legs of a nuscular man. The ar tnal explort took place in Milan, Italy In Germany, studies in man power flight and heing undertaken in all seriousness. In Italy the government has offered valuable prizes for Bight by human muscles Richard C. du Pont is reported to have said that given a glider with a foot-driven propeller, to be used occasionally, he could keep aloft indefinitely and fly across country at will, Evidently the question of muscular flight is not a fantastic one, and is being entertained in many to

sponsible quarters:
Dr. W. F. Gerhardt, of Wayne University
is attacking the same problem in a totally
different manner. It has built a "gron-cyclewhich is in radiny a historiper of the aim
plex possible form. Its hifting element is a
two-bladt di, variable pitch propeller of 14
in two-bladt di, variable pitch propeller of 14
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One woman-power

charming Mrs. De Tuscan shown in our photograph has created three records with his unique device: the first vertical "flight" by muscular power, the first "flight" by muscular power ever achieved by a woman, and an ascent or jump-off of one eighth of an melt. At any rate, this is as beginning.

An interesting piece of research would be to determine whether a light plane with concentional leg driven propeller, a flaspong-wing machine, or a species of helicopter would be best adapted for missular flight —4. K.

MODERN COCKPITS

THII Boring Clipper built for Pan American has passed its manufacturer's tests through the process of the original productions, the Clipper algebraic for the Clipper algebrai

In the early days of flying the plots oxight was hilly more than a cubbhode been a large mull-passager plane of 1927, such as the Beering 40-4, had a cockpit vidual of only 37 enline feet. The new Chippersontial from his a volume of 1078 who feet, more than twice the volume of the control from his a volume of 1078 who feet, more than 1 possesser to comparison of the Busing 270 of the control of the comparison of the Busing 1070 of the control of the comparison of the business of the confort in the execution of its duties, and to house a multiplicity of equipment, Best comfort and expension of the confort and expension

The control room is, of course, located on the upper deck of the hull, with ready access to the engines through doors on rach side of the room. There are six posts of duty in the room. The last and second pilots' stations are at the forward end, with a door to the anchor room at the very front end of the cabin. In front of these stations are the sunplifted instrument panel, the gyro pilot, and the windshield. There are four other posts of daty. A real advance at control room design and practice has been made, which relieves the pilots of the almost intolerable complexity of duties they have to nudritake m smaller ships. If the instrument panel ahead of the first pilot has been so simplified, it is because duties have been subdivided among five or six men and the pilot's duty is now merely to control the flight in a given di rection at the altitude and speed prescribed by the navigator, The navigator has plenty of



The sparious control room of the latest Pan American (hpper ship and, below, the arrangement of the flight deck. See also illustration on page 278, this issue

CONTROL CABIN



soon for be calmer, that table, and may agreed an extraord instruments. The radio operator, placed to the right, nontraine contact with the ground stations and finanches radio bearings to the maygator. The flight engineer has a his disposal the complete set of power-plant instruments and is close to the doors leading to the engineer. The master or watch officer correlates the functions of the other curve members, assuming the functions of a captain. At the back of the control toom is the door to the avagence sobervatory. For

nashings are sample, anobinisme, highly comfortable

For relief members of the crew off duty there are sleeping quarters located in an afcompartment of the upper deck. It is remarkable how these large fiving boats approach the character of the large surface vessel.

MILITARY AIRPLANE SECRECY

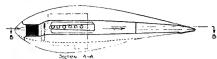
HIGHRANING Aimy officers have pounted on how difficult it is to maintain servery in regard to new arplane designs. Once a machine has been flown, at cannot escape observation and the tlephon is seen the brought into play by the possibly of the possible o

Take, for example, the accident of the Annya "firsts plane" as reported so adminishly in our newspapers, with photographs to make the simuon clearer, it will be remembered that Leutenam Benjamin S. Keltonia, to the Colorana, to the Sphreite Hestalian in discussing the machine here, even though we agree in Europe will seculture the newspapers in Europe will be a seculture the newspapers in Europe will be a seculture to the new form and the seculture the new form and the new for

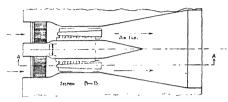
The open dis given as 500 miles an hour a single searce, so says, the press, and notice is thereby served that only speeds of over 400 miles as hour will give a nation speed supremacy. The engines are streamed in the magnetic stream of the speeds of the



Yankee Clipper during a test run



Sketches above and below show details of the novel English scheme for cooling water-jacketed airplane engines without introducing undesirable air resistance



Because there is no way of getting higher speed with a single engine, and because control, laterally, with a single powerful engine is very difficult.

The news stories speak of two booms to carry the tail surfaces. The inference is that accordinating daig is saved the relix it is evidently better to bind a tiny cockpit just log enough to hosse the pilot and use hooms or outriggers, than to construct a conventional dischage to sumont the rear control surfaces.

We road of the use of a trivial banding gear. That means that each for the fastest unitary machine, the trivial landing gear has come into its own. The calm is supercharged for stratesphere or substratesphere work. In the strainhead rose of the cock put there are say ports for the machine guiswith each televal by set classes fluids with the surfaces. The new machine can outly the deduced that the new present is designed to be a most formulable enemy of the bomber.

So the accident served to give the foreign students of the art a mine of valuable information

The inactione was built by Lockheed An craft in 18 months of hard work, and the eccident in no way invalidates the skill of the designers. These extremely fast ships even if they carry the latest instruments and flaps and other devices, still require giral skill, and still encounter accidents even in the hands of such fine seterans as Lientenant Kelsey In fact, the question arises wheth i the new 1P-38 is so advanced, so clever, that the practical mark of military design has heen overshot. Here is a ship which must cost, even in production, something not far from \$100,000. Here is a ship which evidently requires great core to flying. Ifere is an allmetal ship, beautifully streamlined and forished, which it is not casy to repair or maintain. Here is a case of putting a great many eggs in one basket Would it be in time of war feasible to huild and operate a sufficient number of such machines? Would it not be wiser to have a greater number of airplanes, simpler in design, not quite so fast, but built at less expense and easier to oper-ate? Where will we find the super-men that

the world's fastest planes require for handling?

We hope and presume that those responsible for our military aircraft equipment do not overhold, these considerations We do not want an air force of theoretically perfect aircraft, but in insufficient numbers to put up a real fight -A/K

ENGINE RADIATORS WITHOUT RESISTANCE

A FEW months ago we mentioned brief by, and on the basis of incomplete reports, that two young English engineers. Charles Inlin Stewart and Frederick William Meredith, had desised a radiator in which are resistance was found to be nil or even negative. Now a study of the patient challes us to give a more complete statement of the principles of this device.

Let the reader glance for a moment at the diagrammatic sketches. The engine, with its two rows of evhiders in V-arrangement, is placed within the greatest depth of the air-

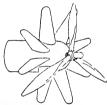
plane wing. On each side of the engine, air tunnels are provided with openings just hehind the leading edge.

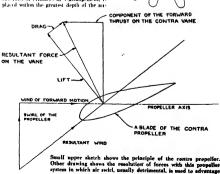
When flying at high speed, the air entertie opening of the tunnel and some of itkinetic energy is converted into pressure, so that cooling arts wideren through thoular radiation placed near the entrance to the funnel. Passing through the radiators, the tie are passes by the exhaust manifolds of the engine, enpirem heat and recovers pressure. Later, the cooling are maxes with the exhaust gas from the manifolds and again its pressure or raised or at least maintained. The two inmutes converge and just into a narrow barround outfor at the rear edge electric.

The reaction of this are μt produces a forward threats which more than compensive, for the loss in pressure when passing through the radiators in effect, a speer's of auxiliary gas engine has been purified whereby some of the heat of the cylinders and of the exhaust has been put to work. We consider this to be a remarkably ingenious idea which deserves to be carefully tried out in practice -4 K.

EXPERIMENTS WITH THE CONTRA PROPELLER

THE amplane propeller accelerates the an in a backward direction, that is how thous is obtained. But it also minures a ro-





311

national motion or swill to the air stream, and this swirl is thoroughly undesirable for two reasons. Since the swirl means kinetic energy in the air stream, rotation of the air moviews some loss in efficiency. Also, when the swirl of the propeller strikes the vertical tail surfaces, it produces a turning tendency for the whole sirplane.

Three defects have long been known, and a device to eliminate the swirl, called the contra propeller, has also been known for a long time. It is only quite recently, however, that definite figures on the contra propeller have become available through experiments at Stanford University, reported in a Technical Note of the National Advisory Committee for Accountage.

the of our drawings shows the purciple of the counts propeller, in which fixed vanisare placed behind the propeller props. An other drawing indicates how the word is taken advantage of to produce an element of forward thraw The forward motion wind and the word combine to give a resolution would which make an imple with the article word which make an imple with the article word which make an imple with the article produces a forward compount of thirst, and therefore the produces a forward compount of thirst.

Experiments in the wind tunnel indicate that for relatively low fring people, the contra propeller might increase the efficiency since 2½ percent, and eliminate half the ward But at high speed, efficiency waacitally both by introduction of the device these results are less satisfactory than had properly the state of the state of the contraction of the state of the state of the perments with this device will be postical—4. A.

AIRPORT WEATHERMAN

IT is convenient for men at work inside a determine instantly what the weather is doing outside. Hence the development of the linken P. Firez Arrport Weatherman Outside there are located a wind vane, a three-ing anemometer, and a thermiometer The wind direction vane operates a synchronous penetrator in a housing located immediately



The airport weatherman and, below, the indicating panel used with it





A light plane for the private flier

below it. The inverment of the generator is communicated electrically to a companion motor in the control room, which actuates the dial of the wind direction indicator. The automotive also operates an electric genration which works with a companion motor below. The distance is adong thermometer is compared in circumsy faching with eighlary tobs, and is greening both. The amount of which is a superficient of the control of the Waltherman most, but it is of qual importance to others working on the archites.

An Interesting Light Plane

P OR several years, Frederick F Week, F Chref Engineer of the Engineering & Research (insportation, has been engaged in the problem of building a light plane which would be entirely satisfied for the private owner and fleer. The Model 3(d), illustrated Week, has passed the tests of the Cavil Astoniaties Authority, and offers many investing features for the private fleer.

Thus, the 310 is almost entirely of aliminum alloy construction—which is as it should be. The only concession, apparently, is that the outer wing panels are failure-cured. A four-cylinder, inverted, air cooled ingine of \$55 horizopower in provided This is just about the right power, and the vision sheaf is very good, as our photograph indicates. There is ade-by-side seating, with a sluling transparent enclosure. Again we always the control of the contr

when the statement that, in a few minter, and the mileton can be inked up. We do not believe in the two-control artplane—that is, one in wheth the rudder has disappeared—but the co-ordination of rudder and ailream may be useful at times and the siles has some possibilities. Also, there as so much longitudinal stability provided and so much vertical fin area below the stabilizer that it is next to impossible to stall the airplane or to keep it in a spin two highly desarble characteristics. With a gross welfalt of 1100 pounds, a top speed of 101 miles per hour, a span of 30 feet, and a wing area of 140 square feet, the new design looks very near and has aroused considerable expectation in the aviation world -4 K

"Pregwood"

Tille Formica Insolution Company has announced a new product, Pri gwood, made by vulcanizing together than laminations of wood impregnated with plannide risms, Cunismal lightness with great density, strength, and resistance to water also-uption are among the claims made for this new material. It is available in the matrial planolic color and is made in sheets. So much or resistance and is made in sheets. So much or resistance and is made in sheets. So much or resistance and the matrial plan is with early 6% inches long It may be used sheet; close manneaume of dimensions in all sorts of weather conditions is important.

COMPLETE FERTILIZERS

PMPIIASIS has lately heen placed on chemoal elements other than nutragen, phospheris, and potassoum in firtilizers. Nuncerous other secondary elements—suffur, magnesium, copper, manganese, boron, and others—are apparently quite as visual to lux-arian growth of plants as the three primary certaining elements, the only difference being in the relative quantities needed, Many soils possess these secondary elements in sufficient abundance but often they must be supplied in the fertilizer.

This istuation has been emphasized in recti years by some fertilizer makers with the implied suggestion that only their products contain all of these secondary elements. Now the word is taken from their sails by a report from the Fertilizer Research Division of the U.S. Burean of Chemistry and Soals that each of 45 samples, chosen as representative of commercial fertilizers, contain all this known scending elements.—

House-flies Prefer Ultra-Violet

IN the Conadian Journal of Research, J. W. MacBain Cameron, of Macdonald College, Montreal, recently described experiments which were conducted with the object of testing the reactions of huma-files to different wavelengths of light. The insects were ferent wavelengths of light.

reared on an artificial nucleum and tested by means of different wavelengths of spectral light obtained from a quater-mercury vapor lamp. The range of the spectrum tested waform 3022 A to 5780 A and the lines were made of approximately equal intensity throughout. The compareson standard, which was used in all cases, was white help tobtained from a tongsten filament fusted bulk

auther from 3 magester manuer misses and the Fless to be steed were removed from breeding eages (en hours before the testeam and the seep in darkas as and as-d It was found that the house fly's much more strongly simulated by after such more strongly simulated by after such more according to the second of the

AUTOMATIC FACSIMILE TELEGRAPH

THE world's first automato to legraph was recently installed at the Essex House. New York City, according to an amountement by Western Linon and the hotel management. The automatic telegraph is the latest development of the telegraph commany's research in facismid telegraphics.

This advance in written communication provides the assist method ever known for the transmission of a relegiant, ofto six state them a child can send a relegiant by this method. The automatic relegraph instrument is busised in a small calmer fast and our the will, and is so simple to operate that relegiants introduced for transmission may be disupped unto a solor in the calmut as easily as electre are discipled unto a solor in the calmut as a substitute of the calmut as a substitut

Only two simple operations are required

by the sender of a telegram. First, it is necessary to push a small button, which is held until a panel reading "Deposit message" is lighted. The message is then dropped into the receiving slot face out. Nothing further is required of the sender.

Several scuding machines may be connested with the same line. If one of them is hosy, a panel reading "Line busy" is illumipated, and it is impossible to deposit a telegram until the line is clear. Once the message is dropped into the machine, it is auto piatically wrapped around a transmitting cylinder which revolves before a photo cell. and is transmitted to the main telegraph offer Simultaneously, a third panel reading 'Message being transmitted" is lit When the telegram has been properly received in the main office another panel reading "Thank yon' appears, and the original telegram is automatically "jorded" from the transmitting cylinder and deposited in a container at the bottom of the calunct,

This type of felgraphy is made possible by the carbon-bearing fishions paper diveloped in the telegraphi company's laboratories. The apparatus is capable of transmitting 15 square inches of matter in our amounts but with the fer attained in commercial facsimile role graphs.

A RECORD FOR VIABILITY

OF SEED

FROM seeds estimated to be between 400 and 500 years old, but a planta are being grown tolds at Field Misseum of National Bistory in Clurago. So far as can be sertained, this represents the longest duration of delayed germination on record, according to Dr. B. E. Dabligne, their Curator of being. The theory of the property of the pr

The lotus seeds had lain buried in a peat

bed in southern Manchutia through several centuries, and were received through the current of the University of Chicago's department of botany. At the time these seeds were produced by nature—perhaps before columbus. First execution into the New World there existed a small lake, about two square nucles in area, covered with red lotters flowers identical with the species commonly found in Ayas tedals.

Records show that this lake was drauned some time between 160 and 250 years ago. Wind-dirfied soil then gradually covered the art, and trees and other land vegetation began to grow. In this basin today are large poplars, willows, and chins. One of the poplars measures from feet in diameter, and there shall have him out drown show at least 250 minuted may the conditions the minimum age of the autocover of beneath the soil bed in which the trees grow. The lower statum containing the seeds is a pear bed that one was the bottom of the lake.

The seeds resemble small dark brown acorns. Their coats are hard as glass and highly polished. These inter-covers are so impervious that the embryos usude have been protected through the centuries.

BETTER WATER TREATMENT

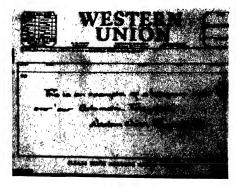
THE lune-soda method of softening hard water normally fads to yield a moduli as soft as might be expected. The hardness of water treated by this process should be



How messages are placed in the automatic telegraph unit and, left, a received message, reduced in size

too low to be significant. However, this is not the case, and treated water retains in super-saturated solution amounts of calcium and magnissium in excess of their actual solubilities.

A new method of applying this common treatment materially reduces the laradness of treated water. The differences between the ordinary method of treatment and the inproved process are apparently trifing modfications. One of these consists in mixing the chemicals for treating a fresh lot of water with altray from water periously treatment and the state of the processing the protessing the processing the processing the processing the processing the processing the processing the protessing the processing the



stirring, filtering, and other operations of the treatment are similarly altered. The result is water having a hardness of 20 to 25 parts per million instead of 50 to 90, commonly met in water softened by the ordinary lune-soda method.—D. H. K.

FARMERS HELP BUILD

CARS

In the production of each 1,000,000 automobiles, it we stanted that the agricultural products from a half-million acres are used. Here is a list of some products of the land consumed in making 1,000,000 automobiles and the purposes to which they are applied, 09,000,000 pounds of cotton—tires, butting, cloth, and brake limings. 500,000



bushels of corn-buyl alcohol and starch, 2500,000 gallon of molasses (from sugar 2500,000 gallons of molasses (from sugar care)—solvents, anti-freeze, shock absorber and anti-starch
WITHOUT INTERRUPTING SERVICES

ANTICIPATED as a probability at the time of erection seven years ago, the all-metal office building of the Department of Public Works, Richmond, Virginia, has recently been moved 400 feet, from the corner of Twelfth and Broad Streets to a new location on Governor Street, in order that the new building of the Virginia State Library might be erected on the Broad Street site. The relatively narrow passage through which the building had to pass necessitated twice swinging through an arc of 45 degrees once before the first forward movement could he made, and the second sandwiched in between two forward movements, each in the direction of the longitudinal axis of the building.

The Public Works building is a two-story structure with full basement. It is rectangular in shape, with a frontage of 117 feet and a width of 52 feet.

The contract-time for moving the building was 60 calendar days from date of award of contract, during which time the building was maintained in a livable condition with all



Left: The all-metal office-building ready to be moved. Above: An air view taken during the moving process, showing the difficulties that were encountered

service facilities, including heat, light, telephone, water, and sewerage, without interruption to the routine work of the Depait ment or its accessibility to the public

Above the first floor, metal predominates on hole extence and interior surfaces, the basement being of mesonry construction. The inner and outer walls are of alumnium in the outer walls, plate and extraded shapes are employed to produce a drop-paniel effect in the pulsaters and entablature. The inner walls, as well as the partitions and doods, are formed from alumnium sheet. The case-ment windows are seed

Because of the relatively light weight of the building, it was decided to move the unreinforced concrete havement walls with the building, in order to lower the center of gravity and to obtain additional longitudinal stiffening of the structure.

EMPLOYMENT

M ORE than 7500 parts from 119 manufacturing plants go into the construction of a standard locomotive, which provides employment equivalent to the work of 50 men for one year.

YOU PAY FOR MILK BOTTLES

THE cost of the bottle is a big item in Mata consumers have to pay for milk. A quart bottle costs originally about five cents. Directly or undirectly, the consumer pays for it. The more trips the bottle makes from dealer to consumer, the less the cost to the consumer.

A study by the Bureau of Dairy Industry shows that many consumers actually do not realize when they destroy or discard milk bottles that the bottle has value and that it is the property of the seller and not the buyer, as is the case with most containers in which food is purchased. Education of the consumer, says the report, is too often

neglected.
The Bureau in a study of 111 milk plants

found that the average life of a bottle was 55 strap, It ranged from sets to 91 trips, but the most common range was from 20 to 30 traps. The system most urdely used by dealers to get bottles back are A commission to route men for bottles returned, a charge for all bottles sold by stores, and a milk hottle exchange, in plants that used all three methods, the average hife of a bottle was over 51 traps.

For plants that used no special system to get hottles back and that were not members of an exchange, the bottle life averaged only a little over 22 trips.

SYNTHETIC TOLUENE

SYNTHETIC methods for producing tool more which are independent of hyproduct roke are being actively sought in Germany. One synthesis which has been successful on a laboratory scale uses benzue and carbon monoxide as the raw materials. Reatton between those two compounds in the presence of a smaller catalysy right hemail-presence of a smaller catalysy right hemail-provided benzue to the control of the presence
MAGNESIUM ALLOYS

IN AIRCRAFT

AMERICA'S supplies of magnesium are practically inexhaustible, and A. W. Winston of the Dow Chemical Company recently. They exist as magnesium chlorade or as magnesium carbonate in dolomitic limestone and magnesite. It is the magnesium chlorade found in the salt brines from wells in central Michigan which provides the nation's major source today.

Landing wheels and engine parts are the principal American applications of magnesium alloys in airplanes, Mr. Winston explained,

Landing wheels on the largest airplanes, if made of magnesium alloys, would mean a weight saving of 150 pounds, or the weight of another passenger. Thus, at present air



Relative particle sizes of three substances, all same magnification

travel farres, a plane with such whirels could theoretically save \$11995 for each New York to Los Angeles trip. Admitting that all of this saving could not be realized. Air Winston added, the opportunity still cross for increased payloads through weight reduction by the use of light wight alloys.

NUMBER PLEASE

M ORE than 2260 tons of nickels, dimes, and quarters are collected annually from New York City's 88,000 coin telephones. Nuctembs of these cams are inckels.

MINUTE COLLOIDAL GRAPHITE

AFTER four years of experimentation. A Athem callonds Corporation has developed a new process of predicting pure "idig" colloudal graphice ou a commercial calle with remarkable small particle size in the properties of maximum size of a colloudal graphice particle is one mercon equal to 0.00005937 of an irish with superfects around co-orderably smaller than

Callordi graphite has for a consolerable unimiter of year been need both as a liberant and for its electrical properties. As a liberant is of the former and the properties is a fifting to the real. Find the properties of the pro

Formerly, however, the graphite would remain in colloidal suspension only in relatively high viscosity liquids such as petroloum oils, variish, glycerine, water, and the

The new small particle size permits the production of stable supersion of "dag" in such low vis ossy highest as electrochemically such control of the production of stable
cation. In addition, it seems to have definite

aminy to return curvision.

The version that the small particles will slay in suspension, apparently, is that the or mass is so small that the "Brownias' moviment imparted to them as a result of their in gative cleering charge will keep them in continuous motion and prevent their flocculation or precipitation.

In the heavier viscosity liquids mentioned, suspension of the new form of "dag" has the advantage of providing much greater stability. The increased activity of the partieles in suspension renders them conderably more impersions to the flocculating tendency arising from a possible contamination of the carrier with either acids or alkalis. From a more practical standpoint, the new development promises to solve a considerable number of tough lubrication and electrical problems such as the dry Inbrication of remote and closely fitting parts, It will also impregnate porous bodies much more readily due to the finer particle size, imparting to such hodies desirable qualities of lubricity, electrical conductivity, color ing, and so on.

CATALYTIC CRACKING

ALTHOUGH thermal cracking processes, by which perroleum is forced to give a higher yield of gasoline, save about two bilhon harrels of crude oil annually, they are likely to become absolute in the face of a (Bialytic process of even higher efficiency. Thermal cracking of gas oil yields 70 to 75 percent of gasoline having an octane number of approximately 72. The new catalytic cracking process produces 85 percent of gasoline from gas oil and this has an octane rating of 81 or more. The process is said to he particularly valuable in producing fuels of high octane rating which are likely to become increasingly important. Aviation potors already require fuel of approximately 100 octane rating, and such motors are likely to become more plentiful in the future-

BUSINESS CURIOSA IN CHINA

THE China Digest, an interesting little pocket digest published in Shanghai, quotes the Shanghai Ecening Post on various curious money-making and money-saving schemes found in present-day China:

In Cliungking, Szechuen province, the article claims, you are likely suddenly to find yourself being fanned by a "fan boy" who rushes up to cool you off as you walk along the street.

Also in Szechuen, "as soon as one enters a restaurant in a small town, a "tobacco boy' steals up stealthily from behind and without warning thrusts a wet tobacco pipe into your mouth."

There are "toe-scratchers" who make a living in out-of-the-way towns by massaging and scratching your toes with various implements while you are having lunch. With the withdrawal of the Chinese gov-

With the withdrawal of the Chinese gosrament from Nanking to the interior, the custom of wearing foreign style felt hat has spread. But with it has spread the custom among the villagers of covering the hat with paper or newspaper passed from brim to top of crown. The intention is to keep the but them.

In southern China it is said to be difficult to hay oranges that are not peeled. The peels are highly valued for tasking a Chinese nucleum. In Shangha, there are shops which deal in nothing but broken glass. Other shops deal only in the whites and volks saved from broken eggs.

RED PIGMENTS

RYSTAL form has been found to be an Important factor in the color of certain pigments, and the crucial one in the valuable red molybdenum pigments now largely used in paints and tuks. Actually these pigments are made by precipitating lead com pounds from solution by adding a solution of a chromate and a molybdate. Actually lead chromate is vellow and lead molylidate is colorless when each is precipitated alone. However, when these two insoluble lead compounds are formed together the mixture is neither yellow nor colorless but red or deep orange Lead chromate normally crystallizein the rhombic system and lead molybdate crystals belong in the tetragonal system. the mixed precipitate assumes a red color only after it has been e-prested to the latter system - D. H. K.

ROTARY WINDSHIELD

CLEANER

A ROTARY-TYPE windshield cleaner, designed originally for aviation use, is now available for ships, small boats, trains, buses, and trucks. Air Associates, Inc., ha-



Rotary wiper in use

developed a rotary type windshield wiper which, due to speed of rotation, is invisible when in use

The blade is carried by a driving head which passes through a hole in the glass, and is driven at any speed up to 2500 revolution-per minute by a flexible shaft from a small electric motor. Pressure on the windshield is adjustable, and the wiping edge was espe-



Close-up of the rotary wiper, showing motor head and flexible shalt

cially developed to withstand oil, gasoline,

suitiguit, and extreme temperatures.

A special feature of the new super is its anti-leng attachment. A metering pump bill into the head of the divining motor forces a special anti-leng fluid from a small tank to the driving lead where it is distributed by centrifugal force over the area weigh the blade. This fluid prevents the formation of ice on the windshield by mixing with the snow, sleet, or spay and lowering its freezing point. When the device is installed on a boat, fresh water can be fed to the wiper to prevent the formation of salt increasing the fluid of the fluid box is controlled by a needle valve.

It is claimed the rotary wind-hield cleaner is easily installed, a special tool being prosided with which it is easy to drill the required hole through the glass. The flexible drive-shaft permits moniting the motor in any suitable location.

AIR CONDITIONED SUBMARINES

Alk conditioning now being installed in submarines will make America's indersea fighting force a much more potent weapon in any future war, according to William B. Henderson, executive vice president of the Air Conditioning Manufacturers' Association

The efficiency of submarines depends primarily on the finess of those who man them and their comfort during long cruses at sea, says Lientenant Albert R. Behnko of the Navy Medical Corps, explaining the latest submarine development.

The use of sooling and dehumidifying aquipment and, the provision of oxygen from tanks to replace exhaled earbon dioxide will enable submarines to run submerged probably for periods of days, thus adding another factor to their effectiveness in attack or defense.

Even with these aids, the men who operate submarines must be trained and "conditioned" for a period of at least ten days between cruises, says Dr. Behnke.

Only the fittest officers and enlisted men are chosen for anbmarine duty, and only about half of the Navy's personnel measures up to the stiff medical requirements.

Few persons realize the difficulties under which submarine crews work. The men muss re-breathe the same air for periods of from three to 24 hours, and perhaps longer under war conditions. They must hee in very cramped quarters, in which all that a sailor owns must be stored in a space about the size of his own body. A bath is something almost unbracted of on a submarine at sea.

When the vessel is submerged, particularly in tropical waters or during the summer, the temperation may rise to 100 degrees, Fahrenheit, or above, and the humidity may increase to the devepoint so that sweating (which tools the body) is impossible.

POISONS NEEDED IN HUMAN DIET

YOU need arsente in your food. Not much of it -so hittle, indeed, that ordinary themneal analysis won't detect it. But if those few thousandist of a snowflake s weight are not there you won't be healthy

The same is true for a couple of other poisonous elements, lead and manganese.

These elements are present in most soils, but in extremely small quantities, and ordinary tillage exhausts them, said G. Donglas Jones in a recent issue of Agricultural Engineering. To make them more available to plant roots, deeper tillage is needed. Mr. Jones is at work on several types of new soil-stirring implements. One of them, which he calls the tipper, works to depths of three feet—Secuece Service.

CLOTH FROM WHALES

W HALE ment has always be n a largescale waste of the whale of industry since the carcasys of whales are enumously left to shorks after the lubber has ben removed. Recent reports from Japan state that whale ment has been successfully need to make artificial fibers, one re-embling wood, and another which combines the product of whale meat with view-to having a sublichte the moment available, but pre-sumably include a formentation of the meat followed by a spinning operation—D H K

CIGARET SMOKING RAISES BLOOD PRESSURE

SMOKING eigarets raises the blood pressure in both normal persons and patients suffering with high blood pressure, Drs. E. A. Hines, Jr., and Grace M. Roth, of the Mayo Clinc, found in a study of 86 persons, according to a Science Service renort.

The effect of tobacco smoking on blood pressure is not due entirely to the action of a stimulus on specially sensitive blood vessel systems. Part of the effect, at least, is the result of some element in tobacco smoke which causes constriction of the blood vessels.



Twelve mitte of hard-subher piping are part of the 50 mitte of pipe installed in the Industrial Baron Corporation's plant where rayon yarm are heing produced by a new continuous spinning process. These pipes carry water, atcam, and processing solutions, hard-vubber being used where other materials would be attacked by the chemicals. The hard-vubber pipes range in size from 11/2 to 81/4 inches in diameter and forms 0 are part of the 290 tons of hard rubber used in equipping the plant. Here, on special machinery, will be produced rayon yarm faishache to exact finness and physical specifications hald downly by fairly carry from the contraction of the 200 minus of the 200 minu

sels. This element in the tobacco amoke was not identified in the report made by the two scientists at a recent staff meeting of the Clinic.

The rise in blood pressore following smoking was greater in high blood pressire patients than in normal pressore except in the case of high blood pressore patients who had never smoked before. This latter difference is attributed to the fact that next perfenced smokers do not inhale as much smoke as regolar smokers.

The test was made by having each person, although a 30-minute rest, smoke two cigarets of a standard brand. Blood pressure and pulse rate were wat hed during the smoking and for a few minutes afterward. As a control, each person went through the same procedure except that he puffed at an inhighted cigaret.

The results were also compared with results of the cold pressor test, in which our band is immersed over the wrist in a bucket of see water. The blood pressure is reported to this test indicates whether or not a person ban an especially seenitive, or hyber-reactive, blood vessel system. The excessive rises in blood pressure from smoding, the scientistic found, occurred only for patients who had befound to curred only for patients who had bereactive blood with a patient with the patients. In prereactive blood we sell systems.

TINY ANTI-FRICTION

A COMPLETE autofraction bearing, which, in the smallest commercial size, is no larger in outside diameter than an ordinary fointing peu, is expected to widen the field of anti friction construction. These space-saving bearing, made by The Torrington Company, are known as nicelle bearings. They comprise a series of small



Bearing compared with fountain pen

diameter "needle" rollers held within a single retaining shell Because they will carry exceptionally heavy radial loads for their comparatively tiny size, they will permit the machine builder to apply anti-friction operation in cannot desirons.

PERKS HAVE GLASS HEARTS!

THE heart of the percolator is the pump —and in the new Pyrex Flameware percolators it is made of a clear, stainless, sparkling tube of Pyrex glass. It never absorbs rancul odors, never discolors, and can easily be cleaned. Recently announced are a



It is claimed that better coffee can be brewed in this glass perk

size up size with administic roller basker and stainless steel fittings, and a nunecup size with stainless steel coffer basker and fittings. Both have the row stainless glaspump which contributes greatly to the brewing of better percolated coffer. These new percolators can be used on any heating

LUMINOUS PLASTIC.

A PLASTIC modding powder in which is uncorporated a liminous material has recently been placed on the market by a British plastic manufacture. This powder, when modded in the ordinary way, yield, but which plow after exposure to atong light. Thus, indicator buttons, figures, let-s, and sumhar articles which must be found in the dark, become luminous after exposure to natured or artificial light. The glow continues for approximately four hours after removal from the light source, but the luminous property can be regenerated at with 2018.

HAIR REMOVAL BY ELECTROLYSIS MAY BE

WOMEN are warned that death may lurk in the seemingly simple electrolysis process for removing superfluous hair, in an editorial in the Journal of the American Medical Association.

The ordinary operator is likely to have little knowledge of assptic technique. The importance of the proper sterilization of the patron's skin, the operator's hands and arms, the needle holders, and the needle is largely unknown to these technicians or may be disregarded. Use and misuse of the machines are increasing.

Infections ranging in effect from mild to fatal may result Examples cited are prictiles, absersees, cryspelas. There is direct communication by veins between the areas of the nose and upper lip with the lateral smises, and infections in these regions may cause death. the Journal states.

Electrolysis is also used by non-medical operators to remove moles and warts. Benign moles may become cancerous through injury Perhaps they were malignant to be-

gin with; the beauty operator and self-styled electrologist would not know

Pitting and sears frequently result from the application of too much current or too long treatment, as well as from the insection of the needles into the hair folliele. If the operator makes several stabs at a single folliele or treats too many hairs in a given area, infection and serious consequences result.

According to the medical Journal, the person who uses electrolyte instruments for beauty purposes should have some understanding of the following anatomy, physiology, bacteriology, antisepos, tissue tolerance to trauma, the chemical reactions involved and the physics and mechanics of the apparatus used. Service Service

MILEAGE

TEXAS, with its 16,000 miles of railway line, has more railway mileage than any European country except Russia, France, Germany or Great Britain.

NEWEST VACUUM PUMPS CREATE LOW PRESSURE

THE emptiest man made space ever attained is now being created by the new est vacuum pumps which nee oil molecules to sweep out the air from scientific apparatus

While it is impossible to produce a perfect vacuum, a vacuum can be created in which it is possible for a molecule to travel nearly 500 feet before it would encounter another nodecule.

Since a molecule is only about 0000001 centimeter in diameter, this means that in traveling 500 feet, the molecule goes more than 100,000,000,000 times its own length liefore encountering a companion. Here, truly, is lonelines.

If the same conjunces were applied to people it will mean that a man 5.2 feet tail would have to travel more than 100,000,000 miles before meeting anyone. The lone lines would be much greater than if there was only one man on the Earth and another on the Sun

In terms of atmospheric pressures, the new oil diffusion pumps, as they are known, can



A four-compartment, three-jet Hickman non-mechanical vacuum pump

produce pressures of .0000005 millimeter of mercury without the use of cooling traps of hauld ar

Normal atmospheric pressure is 760 millimeters of mercury, which is more than a billion times that attained in the newest oil diffusion numps.

In operation, the new pumps consist of

elaborate and beautiful glassware arranged in tubes and columns to make a complete circuit for the vapor of the oil.

The oil is heated at one point in the circuit and the vapor flows around the loop. As the flow passes a specific point, it comes by an opening leading to the chamber to be evacuated. Molecules of air coming out this opening are bumped by the oil noiecules and the latter knock the air molecules away from the container heing evacuated.

Dr. K. Hickman and his associates at Eastman Kodak Company developed the new pumps which are now in commercial production—Copyright, 1939, by Science Service.

VALUE OF RUBBER

THIS year is long rethrated the contents of the discovery by Charles Godyat of the process of submitting tobber to the process of submitting tobber that has met this material weed if Thomedustry based on the themself reaction of sufur with rubber represents an investment of \$2.090,000,000. It employs approximately \$4.000,000 people and annually uses approximately \$75,000,000 pounds of cotton, among other raw materials— D H K

Noise Snubber

A TOTALLY new type of noise-quieting placed at any point in the intake or exhaust-system of an engine or compressor, has recently been developed by the Acouster Devision of the Burgess Battery Company Since it eliminates the cause of noise pro-



It snuhs the slug

duced by the pulsating gases by snubbing the piak velocities and pressures and thereby produces a smooth flow of gas, this new device is called the Burgess Snubber.

Two sero-dynamic effects are involved in the operation of the Burgers Simbler, First, the fast moving dug of exhaust gas, which is vented into the exhaust valve, is trapped no higherestance subbing tithe. This tube is perforated radially to allow the pent-up gas to vent gradually into the first subber chamber. At the same time, a recoil pressure from the mulbing time serves to slow up the flow of characteristic states of the control of t

The abover moving accuraged gases do not enter the subhibit gube but are diverted through a low-resustance chaust tube in the first chamber. A second stage of subbung, comparable to the first, removes any remaining impulses which may be present in the whausted gases. Back pressures can be eliminated or controlled to any desired value. The effect of the Burgess Exhaust Smubber is to prevent the sudden impact of the slug of vented gas with the atmosphere and also to stop the usual inrush of air into the exhaust plue, after the discharge of the slug. Therefore, the sharp noise of the bulg impact and the rumbling noise of the vibrating air column in the exhaust pips are chimiasted.

- 08480 -

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The same type of unit is applicable to intake and output lines of reciprocating and rotary compressors. Burgess Snubbers are available in a wide range of sizes for standard, heavy duty, and spark-arresting service.

STAINLESS STEEL IGNITION CABLE

A NEW ignition cable employing a sevenstrand vainines steel conductor instead of the usual 19 strands of copper wire, has just been amounted by the Sterling Cable Division of The Electica Auto-Lite Company, Because of the extremely low capacitance about helf that of conventional copper



Copper versus stainless steel

cables—achieved by the new construction, improvements in ignition performance result. These improvements lead to increased engine efficiency and worthwhile operating contours, according to the makers.

economes, according to the makers.

Low capacinance, the basic characteristic re-possible for the superior performance of the coble, is a term used by regineers to measure the amount of electrical energy which all cables "absorb," and which a therefore not delivered to the spark play. The less current a cable absorb, the lower us capacitance, and the grater its efficiency. Low capacitance with copper was impractical. Reducing the number of strands weak-med the cable dammetr beyond that of the conduction of the

capacitance in a cable of standard outside

RADIOACTIVITY UNDER-LIES ALL GEOLOGIC

PHENOMENA

WHEN a volcane crupts, butling, into the air great clouds of gas, rocks, and drbris, and pournes forth streams of molter leave, the geologis seeks an explanation in forces working far down in the shell of the earth. When an earthquake shatters the earth Serrent causing great rifts and undermining buildings and road-beds, the geologist again looks far beneath the surface for the cause. The immediate causes of such disturbances are pretty well known; but what is their underlying cause?

Professor Bailey Willis, of Stanford University, has for several years been seeking an answer to this question. One result of his search is the challenging theory which he

MANY STILL ARE NOT AWARE

that there is a companion volume to "Amateur Telescope Making,"

"Amateur Telescope Making — Advanced"

NOT merely a new cellition of the book." Anateur Telescop of the book." Anateur Telescop has a shelly different sook, for oners of that beginners book who have absorbed its contents. "Anateu Telescop Makeng—Advanced" has 57 chapters, 650 pages, 350 illustrations and new 500,000 words, dealing with advanced mirror technic, flat making, expelice work, drives, aluminizing, observatories and many other aspects of the optical hobby Published 1917

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calls the asthenolith, or melting-spot, theory, and which he presented at a meeting of the Geological Society of America. In the April usue of the Society's Bulletin, he sets forth his theory in full or, as he himself states it, places it "on probation."

Professor Willis pictures the earth as having an outer skin or crust, a very thick, solid shell or intermediate zone, and an inelastic, presumably molten zone. This condition, he believes, has existed throughout the entire 2,000,000,000 years of geologic history.

Professor Willis believes that throughout the entire span of geologic time, there have occasionally appeared in solid portions of the earth bodies of molten amter. These bodies, out of which such rocks as granue were later formed, he calls subtenoiths, or nething spots. The melting, he believes, as usued by the interne heat generated when caused by the interne heat generated when furname and thorium, for example) break in jint obter clements.

where it was formed. It grows, and at length ascends. It may rue to the surface of the earth, and the hot molten matter may escape from the mouth of a volcane, or it may well forth from a fissure as a laws flow. It may, on the other hand, end its ascent before reaching the surface, and cool and crystallize at some place within the earth's crust. In one or the other of these ways much of

An authenolith does not remain in the snot

our grante and other works were formed. From in terms of geologic time, the rise of an asilennoluth is exceedingly alow. Ceologicasts believe that the interval that has elapsed between such intrusions is of the order of 100,000,000 or 200,000,000 years or more. Professor Willie invites consideration of his theory as an explanation of some of the most important and striking geologic phenomens, and as the rev of great mountains from having or troughs, the process of metamerphase, by which rocks are of metamerphase, by which rocks are shapes, and testimes; and the activity of welcances and carthonialses.

IRON TONIC FOR TREES.

I OW grade tron ore, limonite, is being used to treat high lime soil to overcome chlorous in trees. This disease is evident in the hleaching of the green of the trees' leaves. Apparently iron acts as a tonic to overcome thus disease. — D, H. K.

Danger of Fire From Electron-Metal?

Dr. Voskuehler said that all articles made from solid magnesium alloy are in no way combustible or flammable, and that the same is true of the metal plates and waste



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scraps. If exposed to extreme heat, the alloy may melt and this molten mass may burn, but the conflavration does not extend bevond the point of contact with the extreme heat. The metal shavings and scrapings which are produced when the metal is being machined can be set on fire by a strong flame and will then burn up slowly, piece by piece. Such a fire as this can easily be extinguished with dry sand, Water or other fire-extinguishers, however, should never be used to put out magnesium alloy or electron metal pieces which are on fire, as the water breaks up into oxygen and hydrogen under the high temperature and an explosion may result

Large accumulations of metal shavings and scrapings of this material should be avoided in the workshop or lahoratory. The dust from this metal is also llammable just as coal dust or any other dust is flammable, and care should be taken that it does not collect. In granding or polishing this electron-metal, only non-seed oils should be used These precautions apply to the workshop and factory only, as the finished article is entirely non-flammable and cannot catch his under any cur unstances

CCC GETS CREDIT

YOUNG men of the CCC camps were given credit for saving millions of acres of farm and pastore land, in a communication from H. H. Bennett, chief of the Soil Conservation Service to Robert Fechner, ditector of the Civilian Conservation Corps CC Comps furnished 70 percent of the labor used to advance the soil conservation program, Mr Bennett said

In fighting gulbes, the last and worst stage of soil crosion, CCC workers have built almost 3,000,000 check dams, dug 48,000,000 linear feet of diversion duches and seeded or solded 300,000,000 square yards of gullied land In combating the less spectacular but more insidiously destructive sheet crossion they have planted approximately 500,000 acres, put in 18,000 miles of terraces and 41,104 miles of contour furrows, and quarand 1,403,659 tons of lunestone -- Science Service

EFFICIENT MEGAPHONE

Some megaphones are apparently designed by reason rather than acoustics Reason dictates a long, narrow, round "di-rective" shape, but Prof F. R. Watson, experimental physicist at the University of Illinois, has worked out the design of a highly efficient megaphone which some might lie tempted to say in advance of test would not be successful. It is short, has par allel sides and, still more surprising, it is held in a vertical position as shown in the illustration In acoustics, things are seldem what they seem.

"Following a suggestion by Lord Ray-leigh that a megaphone with a rectangular apriture could be used to direct sound, such an instrument was constructed and found effective in directing speech sounds," Professor Watson states.

"Experiments with megaphones varying in size from six feet in length to one foot led to the adoption of the smaller size for practical use This megaphone can be made of thin wood or metal; it has parallel sides. two inches apart, with a square mouth opening two inches by two inches, with an outer





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opening from which the sound emerges two inches by six inches, and the length from the month opening to the outer opening 12

inches. "The megaphone should be held with the six-inch dimension vertical, in which case the sound spreads sideways covering an angle of more than 180 degrees When di rected at the center of a row of bleachers at an athletic meet, it sends the sound to all the auditors, including those in the end





How the new megaphone concentiples sound, wastes little energy

scals. Very hitle of the energy is sent vertically up or down, so that the migaphone thus places practically all the sound effec-

"In addition to its directive property, the megaphone amplifies sound as all megaphones do It can be used effectively in anditorms, particularly in rooms with low ceilings where hearing is difficult for auditors at some distance from the speaker. It is also useful for baseball ampires in making annonneements, for military officers in directing commands to an extended group of companies, and for other similar situations

AVERAGE AGE OF EMPLOYEES Is Over 40

THE average age of employees of United States Steel companies, as reflected in group life insurance statistics compiled as of May 1, 1938, was 40.17 years. The num her of employees insured represented 97 per cent of the total number on the payroll

Employees are almost equally divided be tween those older and those younger than 40, the older group accounting for 493 per cent of the total and the younger group 50 7 percent. A total of 26,207 employees, or 134 percent of the entire number, are 41 to 45 years of age. The next largest five-year age group, 31 to 35 years of age, totals 25,711 employees

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words, not more than nine pounds of pigment should be used per sack of cer Deep shades can generally be produced with less than this amount of color by judicious choice of pigments. To insure thorough mixing the pigment should be at least as fine as the cement; the finer the pigment is

ground, the greater its coloring ability.

A general guide to the selection of colors and coloring materials for various effects, prepared by the Portland Cement Association is listed.

For blue shades, use cohalt oxide. For browns, use burnt umber or hrown

oxide of iron. For buffs, use vellow ochre or oxide,

For gravs, use small quantities of man ganese black, black iron oxide, or germantown lamp black; preferably black from oxide.

For greens, use chromium oxide, For pinks, use small quantities of red oxide of iron.

For red shades such as light brick, terra cotta, and so on, use red oxide of iron. Vene-tian red should be avoided.

For slate effects, use manganese black, black iron oxide or germantown lamp black, preferably black iron oxide Common lamp black should not be used.

Different shades of color can be secured by varying the amount of coloring material used, or by mixing two or more pigments. The full coloring value of pigments can be olitained only with white portland cement, When clear white is desired, white sand and winte cement should be used. The use of white portland cement with yellow and brown sands will produce varying shades of cream, yellow, and buff, If the colors can be secured without pigments such practice 14 recommended.

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Too Much Early

ENTHUSIASM

E XPERIMENTAL results obtained by using super-voltage X rays in treatment of cancer have not justified high hopes entertained when they were introduced five year-ago, Dr. Robert S. Stone recently stated in a lecture at the University of Chicago.

"Although there is very definite improvement when X-ray doses are increased from 100,000 volts to 200,000 volts, increases be yond 200,000 volts apparently reach a point of diminishing returns," Dr. Stone said.

"The 100,000-volt X rays have been abandoned in the treatment of all but surface cancers. But after 200,000-volt magnitudehave been reached, the important opportuni ties for improvement lie in devising better techniques of administering the X rays, rather than in raising voltages.

"The effect of X rays is to ionize and knock down cells. The usefulness of the rays lies in the fact that cancer cells 'can't.



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take it' and do not recover from the ionization disturbance as well as do normal tissue cells.

"It is the differential in the effect of the X rays upon the two types of cells that gives the rays any effectiveness they have. The aum of radiation therapy has been to make that differential as wide as possible, so that as little normal tissue as possible would be affected per given amount of disturbance of the cancer tissue. The danger of the increased penetration afforded by the supervoltage X rays is that they pass through one side of the body and through the cancer. and then also pass through the opposite side,

injuring that tosue also.
"On the basis of the improvement in raising the voltages from 100,000 to 200,000 there should have been a slight theoretical advantage in raising them to 1,000,000 Clinically there has been none

CASTS OF ROCK CARVINGS WITH LIQUID RUBBER

NEW and interesting method for ob-A NEW and interesting method for ou-taining easts of rock carvings and rime stones has been perfected by the Swedish Government Antiquarian Office, It consists of spraying a rubber solution over the object one or more times according to the deject one or more times according to the un-sured thickness of the mold. The material dries very quickly, and afterwards the mat only has to be rolled from the carving. Such a mat constitutes an excellent and exact casting-mold of the carving from which it has been taken; from it any desired number of perfectly sharp and chur copies can be

In 1938, 10 rubber molds of this type were taken, and all turned out extremely well. This novel method seems to have doomed entirely the old fashioned system by which the carvings were reproduced by means of a plaster cast - Holger Lundbergh

COUNT THE MILES YOU SKATE

HERETOFORE, roller stating has meant hours of aimless gliding until aching muscles told us it was time to stop. As Major Bowes might say, "we go round and round and where we stop nobody knows Now for the first time we can accurately

Mileage measurer for skates

measure the distance we skate. Instead of waiting for a tired body to demand a stop, we can decide before-hand how many miles we would like to glide six, eight, ten, or even twenty—and stop when we reach our "destination." This is made possible by the Skate-O-Meter, a new invention by Samuel Segal, which records the mileage covered while skating.

The Skate-O-Meter acts as one of the skate wheels and contains a series of in-



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ternal gears which operate as the wheel turns. The gears control a pointer on the the wheel turns, the pointer moves to in dicate the miles and fractions of miles covered. The gear control is so adjusted that it compensates for the time the skate is off the ground. The Skate-O-Meter will record up to nine miles and then start all over again It is standard equipment on Segul Keyless ruller skates, and will be marketed for use on others

FIRST NATURAL BED OF

THICK reefs of sodium bicarbonate, perbeen identified by Dr. William F. Foshar. Smillsonian Institution Curator of Mineralogy, from cores brought to the surface from depths of about 300 feet under an ancient lake hed at Searles Lake, California When holes were driven to the 300-foot level it was found that layers of almost pure sodium bicarbonate and clay alternated.

Used by housewives and dyspeptics for generations, sodium bicarbonate has always been a manufactured product, made from a hase of ordinary table salt by a complex chemical process

A HUNDRED THOUSAND U. S. TANKS

F a major war comes, the U. S. Army will need tanks by the hundred thousand, Maj. Gen. C. M. Wesson, Chief of Ordnance, warned leading automotive engineers re cently. Now it has only a few hundred. Nearly a year from the date war is declared will be required to start mass production of the track-laying battle wagons, he predicted. Labeling an unofficial estimate of 280,000 tanks per year for war by a modern army as too high, General Wesson declared, however, "there can be no doubt that our requirements will be very large." The army is now relatively poor in tanks, having little more than enough to equip a mechanized brigade, This brigade, stationed at Fort Knox, Kentucky, is, however, sufficient for tactical experts to work out the proper ways of using the land

cruisers in time of war. Tanks are at present constructed, with the exception of certain parts, at the Rock Island, Illinois, Arsenal and not by private manufacturers because of wide variations in the number required from year to year and because the number needed is at most small. But in wartime, the resources of the automobile industry would be needed.

American tanks are among the world's best partly because of two unique developments, General Wesson continued One of them, scoffed at at first, is the use of aircooled radial airplane engines to power the mobile weapons. This has resulted in the motor making up but 3 percent of the tank's weight, an unusually low percentage. Heavi er guns and armor plate can therefore be mounted

The second is the invention of a steeltemforced hard rubber block for the track The rubber tracks last twice as long as steel tracks, which are widely used on ordinary tractors and on tanks in other countries. They also improve the tank - performance -Convergly 1939 by Science Service

GOLD-PLATED REFLECTORS AID IN DRYING AUTO BODIES

GOLD, which has found its way into obteeth, has been pressed into service to dry the enamel on your new automobile in one tenth the time required by older methods Special heating lamps, equipped with gold plated reflectors costing between five and seven dollars each, have been developed by the General Electric Company's Nota Park laboratories to line the walls of drying ovens in auto manufacturing plants

So efficient are the new reflectors -about 98 percent for the warm infra red rays- that even after operation for several minutes, the outside of the reflectors is still cold to the touch

The new lamps, each of which consumes electricity at the rate of 250 watts, have been in service for several months in the River Rouge plant of the Ford Motor Company for which they were developed. Steam baths lutherto used take about 10 times as long to dry the car body Special electric controls turn the new heating lamps on and off in a traveling wave as the painted body pass through the drying tunnel -(opyright 1939 ly Science Service

POWERFUL ANTISEPTIC

NEW concentrated antiseptic has been A NEW concentrated antiseptic has been developed which is also effective against the filaments and spores of epider mal phytons, best known in their manifesta tions as "athlete's font." In the concentrated form the phenol coefficient is 5 against the standard test organisms, Lberthella typhi and Staphylococcus queeus, This means that as an antiseptic, germicide, or disinfectant it can be used in a dilution of 100.1.

Aside from general uses it is replacing the familiar chlorine disinfectant of the foot baths of swimming pool locker rooms Being odorless, it is not objectionable and being stable there is not the deterioration in strength which usually occurs. Even at a dilution of 1.1000, it kills the filaments al though not the spores of the phytons.

The product is not irritant to the skin in dilutions below about 1:20 and for general disinfection where a high margin of safety is desired can be applied at that concentration. It does not damage rubber or leave a deposit on the skin.

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FRICE \$18.00 20.00 21.00 30.00 | R P M | C1 | FT MIN | INLET | OUTLET | 1750 | 160 | 4½" | 33½" | 1750 | 350 | 6½" | 33½" | 1750 | 753 | 8 " | 4½" | 6 " TYPE 11 1 0.5 PRICES QUOTED ARE FOR A C 110 V 60 CYCLES ONLY OTHER VOLTAGES ON REQUEST.

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IMPROMPTH PORTRAITS

I MPROMPTU portraits do not always mean "candid" in the strictest meaning of that word, photographically. A candid snap-hot is generally regarded as one taken out the subject's awareness; that is, o made without so much as an if-we-may, But there is another type of portrait, which is not strictly candid because the subject faced the camera and was shot with his consent and eo-operation, but yet is not a formal portrait. Let us call this the "impromptu portrait -taken at the spur of the moment as the photographer happens to be passing by, or while at home or visiting he decides suddenly to make a portrait then and there. on the spot, with no preparation whatever

The perfect example of the impromptu portrait is "Barney." We were going out for a picture-taking walk and stopped for a few minutes' chat with the doorman. He expressed curiosity about the numeture camera slung from our shoulder and, one thing leading to another, we stood him up against the wall near the door and shot him. The lighting was nicely diffused as it came through the glass-paued door, with the result that good modeling prevailed from the highlights to the shadows. But then one can always depend on daylight to furnish ideal lighting for photographic purposes.

The portrait of William Herrschuft, on

collaborator on the recent book, "Lighting Ideas in Photography," was taken during a hill in our work on the book as we were chatting anniably and discussing the next job to be done. He was lessurely smoking a eigar. His mood was right for the picking And the camera being handy, snap came another victim.



Another time we were making some flash

shots at the judging of the most recent

Scientific American annual contest. We had flashed Ivan Dmitri, McClelland Barelay,

and Robert Yarnall Richie, the three judges,

in the act of judging the show and as they

stood chatting. We had come down to our last flash bulb when it was time for the

"Co-Author"

Mr Barelay came along. After some kidding, he walked over to the glass and started to draw a figure on one of the panes. As he did so, we thought of that last bulb and made the best use of it we knew, with the result that you see in one of the illustrations shown here. Before shooting, knowing that one shot was all we could have, we waited until the artist had nearly completed the figure and until his profile faced the camera, smiling and full of animation,

The other two illustrations reproduced are as nearly candid as any portrait can be. The picture of Governor Wilbur L. Cross and Charlotte Greenwood, the actress, was obviously taken when neither was aware that a camera was being pointed at them. The event was a soft-ball game involving many interary and artistic lights, including Lowell Thomas, Heywood Broun, and others. With others camera-bent we had the run of the place, and shot practically at the first show of a celebrity. As the actress approach the Governor and placed her hand on his back, comradely fashion, just before accom-panying him to one of the ball-throwing



"Barney"

ceremonies, a snapshot caught both in Jovial, lively mood. An event such as this one, where the photographer can go practically where the photographer can go practically where he pleases and where no restrictions apply as to what pictures he may or may not take, is heaven-sent hunting grounds for the ammateur worker who is so offert shunted away from subjects apparently reserved soller for prese purposes.

onley for press purposes. The shot of the snager was made on the occasion of a benefit stage performance. This one is in the true canded style, with the subject completely unposed. Nevertheless, it may reasonably be called a sort of fluard portrant of the singer, alogether different from the sort of thing one would expect in a portrant either formal or semi-formal it as a portrant of the singer in action, a posterior of a singer's mood. The general public would book at the picture and cell it a stage



Celebrities

shot; the friends of the super might say this was her real self, the self that could not always be recorded in a straight portiant, incidentally, the picture was shot from the front row, a distance of about 17 feet from the subject, exposure 1/2 at 1 50th second on fast pan film.

These are a few of the opportunities that may be met with in this connection. Many of the results will be better than anything you could get in careful arrangement of posing and lighting; many of them may



On the stage



"After the Contest"

be so had they will have to be thrown away. But have you not often heard the remark of the lady who said that that snapshot you casually shot as she was sitting on a hearch in the park was the best putture anyone had ever made of her? True portraits are not always made in a studio or in an clabiorately arranged composition at home.

START WITH A TITLE

COMETIMES the remark is made about a certain picture that the caption or title under the picture put it over. However that may he, though we are personally of the opinion that a picture should speak for itself, why not try reversing the procedure and make a picture to fit a given title? It may be a word, a phrase, something you have heard or read. This is not the easiest was in the world to make a picture, but it does offer a challenge to our - ingenoity and ability to interpret an idea photographically. And after the nicture has been achieved in a manner fulfilling the thought contained in your title plan, perhaps you can dispense with the title, after all, and let the picture speak for uself, charly, and without benefit of any title.

CASH FOR KORELLE SHOTS

If you own a Korelli, Refex, the distributes of this camera are perpeted to pay you "at the usual rates for exceptional shus made with this camera." The distributers, Burke & James, Inc., invite you to send them what you think most satisfle, or at least write them a description of what you have, Incidentally, whether or not you own a copy of their recently completed brochine. "The Story of Korelle Refex."

Written with particular reference to the Korelle, the brochure also has much information of general interest, discussing varous branches of photography—scientific, candid, portrait, and so on,

Too Much of a Good Thing

O NE of the national photographic dealer magazines recently reproduced a photograph showing C. W. Gibba, A.R.P.S., addressing group of photographic fam. The picture was a flash shot which called for about a half dozen flash bulls in order that the entire hell might be adequately lighted during the brief split-second synchromized.

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For Real Picture Thrills

For action, speed, split second picture thrills—the chrome finished Super Baldina is the speed camera of the age, It has the F 2 Xenon Lens in Rapid Compur shutter with speeds up to 1/500th part of a second with all controls centralized for quick, accurate and easy operation. Automatic focusing is accomplished by the coupled range finder, insuring sharp pictures always. Self erecting feature, hair trigger release, 36 exposure cartridge and other helpful points. Weighs only 12 ounces. Uses 35 mm. black and white or Kodachrome color film, Picture size 1 x 11/2 inches.



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Fourth Annual Scientific American AMATEUR PHOTOGRAPHY CONTEST

Since the preliminary announcement of this contest, which appeared in our April issue, we have extended the prizes to include Third and Fourth places in each of the three divisions

Specific rules for entering this contest are given below. Please read and abide by them to insure against disqualitection. You may submit pictures in any or all of the following disasons.

Division 1. Haman—including portraits and other camera studies of people.

Division 2. Landscapes—including all scenic views, closeups of parts of landscapes, seascapes, and so on. Division 3. Action—including all types of photography in which action is the predominating feature.

In each division there will be prizes of two Longines watches*—"The World's Most Honored Watch"—and two Federal Enlargers, as well as live Honorable Mention Awards

The Prizes Given for the Best Photographs in Each Division will be

FIRST PRIZE
One \$250 "Lifetime" Longines Wetch

SECOND PRIZE
One \$125 Longines Wotch

THIRD PRIZE
One Federal #636 Veriable Projection
Printer (List Price \$29.50)

FOURTH PRIZE
One Federal #120 Enlarger
(List Price \$17.95)

Five Honorable Mention Awards, each consisting of a one-year subscription to Scientific American

Remember that these prizes are to be given in *each* division—or a total of six watches and six enlargers totaling \$1207.35 in value, plus 15 subscriptions to Scientific American

Watch winners may make their own selection of

RULES OF THE CONTEST

- I The groups will be judged independently on the basis of pictorial appeal and technical excellence. The decision of the judges will be final. In case of a tie for any prize, duplicate prizes will be awarded to the tying contestants.
- 2 Prints must not be smaller than 5 by 7 or larger than 11 by 14 Prints need not be mounted, but may be at the contestant's option
- 3 Photographs must be packed properly to protect them during transportation
- 4 Non-winning entries will be returned only if sufficient postage is included when the prints are submitted
- 5 Each entry must have the following data written on the back of the print or mount. Name and address of contestant, type of camera, and film, chlarger and paper used.
 - 6 Contestants may submit no more

- than two prints in each group, but may enter any or all groups
- 7 Prints must be in black and white Color photographs are not eligible
- 8 Prize-winning photographs will become the property of Scientific American, to be used in any manner at the discretion of the publisher
- at the discretion of the publisher
 9 Scientific American reserves the right to purchase, at regular rates, any
- non-winning entry
 10 No entries will be considered from professional photographers
- 11 All entries in this contest must be in the hands of the judges by December 1, 1939. Results will be announced in our issue dated February
- 12 This contest is open to all amateur photographers who are not in the employ of Scientific American

THE JUDGES:

McClelland Barclay, artist Ivan Dmitri, artist and photographer Robert Yarnall Richie, commercial photographer

> Address All Entries to PHOTOGRAPH CONTEST EDITOR SCIENTIFIC AMERICAN 24 West 40th Street, New York, N. Y.

exposure. The photographer was standing on the platform back of Mr. Gibbs and apparently had intended to make the shot as the lecturer was facing the crowd but just before the flash went off a little noise back of the speaker made the latter quickly turn around to face the photographer. As he did so, the photographer flashed the whole battery of bulbs in Mr. Gibbs face as well as the faces of the audience. The result was a white wash of the speaker's countenance with the part of the speaker's countenance with the production of the production on an artist was put on the pile and sketched in Mr. Gibbs face. And that is the way the picture stands reproduction the nugarance

No More Scratched Film

AMATEUR photographers can now treat their own films so as to render them impervious to scratches, abrasion, and finger prints. By means of a patented process that toughers the gelatin, and that can be applied at a cost of fees than two cents a roll, all eizes



Vaporator

of blin from 33 mm to 116 can be treated in a few minites and with no more trouble than doing your own developing. The process known as "vaporating" and is accomplished with the FR Vaporator, with which two rolls of film of the sizes mentioned can be treated at our time, except the 116. In the latter aire only one roll can be vaporated at one time

Films are unserted into the device in the same manner as for developing and then placed in the vaporator Chemical "A" is inserted with a dropper and the cover closed After a few minutes, chemical "B" is inserted and in just a few minutes longer the films are completely treated.

The results obtained today from good cameras, skilful photography, and careful developing would seem to be worthy of this protection which should assure the maximum of satisfaction in nicture taking.

PHOTOGRAPHING THE WAR GAMES

THE war games are being photographed on a larger scale than ever before, ac cording to Harwood Hull, reporting the recent Navy maneuvers for The New York Times.

Ilmes,
"Practically every action recordable by the
photographic lens," writes Mr. Hull, "whether from the air or from surface ships, has
been supplied to Admiral C. C. Bloch.

"One technique carried to a new point in the war game has been simultaneous photography from two or more planes with cameras

operating under radio control.

"These pictures will supplement the maps
at telling the story of the White and Black fleets at the critique. Both maps and pictures will be seen for the first time by the navy flag and staff officers when they assemble at Guantanamo."

CLEANING GLASS

WHETHER you are cleaning ground glass or plain, there is a simple homespun procedure that will do the job most thoroughly Just wash it with soap and water, first one side, then the other, Follow with a runse to remove the soap completely. Stand the sheet of glass so that the water runs off from one corner, Finish the routine by wiping with a clean, soft white rag. The ground surface of ground glass will seem to vanish, giving the sppearance of clear glass, but this effect disappears upon drying

TALKING SLIDE FILM DE-SCRIBES INDOOR PHO-

THE result of more than two years of tesearch, a 25-minute talking slide film on indoor photography produced recently by General Electric's incandescent lamp departineut at Nela Park is now being made available on a free rental basis to camera



From "Pictures Indoors . . ."

clubs and other groups. Entitled "Pictures Indoors with G. E. Mazda Photolamps," the new talkie is said to have been "designed to meet an urgent need for trained speakers expert in Photoflash and Photoflood tech-

Using non-technical language, the film covers the fundamentals of indoor photography in more than one hundred "how to slide pictures, "Free use of the human interest appeal is employed," we are informed, "this element being provided by a genisl photo veteran and a candid young amateur. The secrets of successful indoor pictures are revealed one by one as the expert and novice discuss their hobby."

Starting with a description of the types, construction, and operation of the various types of Photofiash and Photolamps, the types of Photohasn and Fundaments, on-film leads the audience step by step to an understanding of indoor photographic prac-tice. A French doll is the subject and ministure lighting equipment plus a miniature



ters you in competition for this cash prize. Be sure to send your prints, with a notation of the enlarger used, to Scientific American—not to Fed-eral Stamping & Engineering Corp. See contest an-nouncement on the opposite page.

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This book is designed especially for those who have their developing, printing, and enlarging done at the photo shops. No wadning through esotieric darktroom formulas, no space wated on things that you don't need to know. Attention is concentrated on those facts that will help you to get the best results with your

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WHETHER you own an inexpensive box camera or a high-pixed "Special-Ultra-Extra," this book will belp you to get the best results with the equipment at hand

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Photo-Markets

This 144-page book tells what to "shoot," how and where. Gives directions for submitting photographs to magazines. Lists hundreds of markets for photographs, together with the types most suitable for each.

Eighth Edition Revised-Up-To-Date 50 Cents, Postpaid

SCIENTIFIC AMERICAN 24 West 40th Street New York City camera illustrate the various methods demonstrated. The presentation also includes numerous examples of interesting indoor pictures taken under the lighting set-ups described. The final sequence is devoted to interesting examples of good picture subject matter likely to be found in the average

To obtain a copy, a request should go di rect to Incandescent Lamp Department (166), of General Electric Company, Nela Park, Cleveland, Ohio. The borrower merely pays transportation charges and agrees to return film and records promptly. The talkie is supplied by the nearest division sales office of the company. The borrower is also sup plied with literature describing how to operate the film, where operating equipment may be obtained, and with a summary of material in the film

NEW KODAK BUILDING

MORE than \$100,000,000 was spent on amateur photography in the United States during the year 1938, we learn from the Eastman Kodak Company as they an nonnce the building of a new plant at Rochester.

"Sales in cameras and photographic sup-plies shattered all records," they report. and the year ended with a new high of more than 18,000,000 cameras in active use

in this country. "With confidence in the future the Eastman Kodak Company lias announced an imprecedented expansion program to main-

tain this momentum." Incidentally, the company is dropping prices all along the camera line.

PRESS PHOTOGRAPHY AWARDS

SPEED Graphic cameras are still the favorite among press photographers, judging from the fact that Speed Graphic pictures took all five of the prizes offered this year for outstanding news pictures made during 1938, including every one of the 10



honorable mentions. The awards were made at the Annual National News Picture Contest sponsored by Editor & Publisher. Graflex-made cameras have made every one of the 35 prize winning pictures since these events were inaugurated in 1936.

The award, the Graflex Press Photography Award, symbolized by a gold, diamond-studded watch charm, went to the following photographers: Ray Howard, of the New York Journal and American, first prize for "Death on Fifth Avenue"; Howard Jones, of



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the Knoxville (Tennessee) Journal, second prize for "No Pictures"; Charles Haacker, of Acme Newspictures, third prize for "The Warde Suicide"; Ralph Morgan, free lance of Newark, New Jersey, fourth prize for "Thomas Egged Out"; and Charles Corte, of Acme Newspictures, fifth prize for "Couflagration.

The Folmer Graffex Corporation points out that the awards are given solely as recognition to prize-winning photographers who make dramatic, story-telling news pictures and that eligibility for them in no way relates to the kind of camera equipment used.

PRIZE WINNER

FEELING for composition, careful se-lection of viewpoint, and the most effective lighting brought Eugene Lesser, 15year-old student at the High School of Music and Art, New York, the highest honor awarded to any contributor to the second scholastic salon of photography of the Amera-



"Gentatrix"

can Institute of the City of New York. The picture, here reproduced, is called "Genta trix,' showing the boughs of a palm tree photographed from below. The print was hosen as the finest of 308 prints subuntted by 291 students from junior and senior high se hool-

Young Lesser has demonstrated real aptitude in several branches of the arts and it was natural that he should carry his artistic alulity over into photography, towards which he seems to lean most strongly. Certainly, this provides a strong argument for the need of artistic training of some sort if one is to reach the heights in photography. Nevertheless, it must never be forgotten that photography is first of all a mechanical art, and that until the technique is thoroughly acquired, no amount of art leanings or art training igoing to make one a good photographer.

KODACHBOME PROCESSING Now Includes Mounting

FFECTIVE April 1, all Kodachrome K828 and K135 film sent to Rochester for processing will be returned in the form of individual transparencies, ready-mounted for immediate projection, and with no added charge, according to an Eastman announcement. The new service includes lacquering the emulsion side of each roll of film after processing (as a protection against finger marks), cutting the frames apart, and mounting each frame in a serially numbered



- KODAK BANTAM SPECIAL . . . Lens, Kodak Ansaugmat EKTAR f 2 0. Shuiter, 1/500 Compur-Rapel, Coupled built-in range fieder with adjustable eyepiece Film-contering device Brilliant finish. Price, \$87.50, with field case.
- 2 NEW KODAR BANTAM 1.4.5, with Kodak Anastigmat Special lens, 1/200-second shutter Plunger type body shutter release. \$22 50-a new low price.
- 3 NEW KODAK BANTAM 1.5.6, with Kodak Anistigmat lens, 1/100 second shutter Folding optical finder. Film-centering mechanism. \$14—a new low price.
- Kodak Bantams lead to pictures as big as themselves; modern photo-finishing methods give you 234 x 4inch black-and-white prints.

The models above take both Kodachrome (full-color) Film and Kodak black-and-white films. Other Bantams, for black-and-white pictures only, include an f.6.3 model at a new low price of \$8.50, and an f.8 model at a new low price of \$3.95. At your dealer's . . . Eastman Kodak Company, Rochester, N. Y.

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MONOBARII Single solution fixer-developer Developer and fixer in one bath under automatic chemical control. Inventors and manufacturers of Monobath claim negatives always develop to same density regardless of time or temperature Solution works at any room temperature between 70 and 80 degrees, Fahrenheit Choice of three types varying as to gamma and grain, and ranging from Minal Type, which is ultra-fine grain but low gamnia, to Centact Type, which is high gamina but only standard grain. "Negatives cannot be over-developed in Monobath," the manufacturers claim "After the specified processing time of, say, 25 minutes has passed, nothing further happens if the photographer purposely or forgetfully leaves the negative in the solution for an hour or even overnight. When the image has reached full tonal value, development ceases and fixing begins This automatic chemical time cycle built into the formula yields definite density control without watchfulness on the part of the amateur, who is told he can now 'throw away his thermometer and clock'"

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ing 51's inches. Base, turret head, and hous ing of die-cast aluminum with glossy, jetblack finish, contrasting with bright, natural aluminum turned finish of 5-inch lens tube Fluted sides, finished in black crackle Optical system consists of spherical glass reflector; 100-watt lamp; three condensing lenses, and 5-meh f/3.7 projection lens Special heat-absorbing glass prevents overheating slide during projection. For long projection throws, 7½-inch projection lens available. Ventilation provided as follows: "A special shell containing glass wool sur-"A special shell commining gases now sur-rounds the lamp. Liberal space is provided inside this shell, and a similarly generous space separates it from the outer housing. The fluted exterior surface of the housing further aids in heat dissipation. In the design of the projector top, the principle of natural-draft ventilation is employed to exhaust heat rapidly, and louver strips are set vertically to incure maximum circulation. Supplementary louvers are provided over the condenser system."



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IACOB DESCHIN, conductor of our "Camera Angles' department, will answer in these columns questions of general interest to amateur photographers If an answer is desired by mail, enclose a stamped, addressed envelope Queries should be specific, but Mr. Deschiu cannot undertake to draw comparisons between manufactured products nor to advise on the purchase of component or materials -- The Ednor.

Q. Suppose one were going to purchase an f. 3.5 lens and had a choice of one from the following lenses: Xenar, Primotar, or a Tessar. Which one should be purchase and why? Will you please send me details on the above leuses as to color correction, definition, and the number of elements?---W. O.

A. The lenses you mention are all of the so-called tessar-type, consisting of four elements and fully corrected as to color and definition. Any one of these lenses will give results practically equal in quality and it would be difficult for anyone to tell from the resulting negatives which lens made which negative.

Q. I cannot find a method which will give smooth flat prints. The ferrotype plates I use give me such curled prints that I consider them useless. The method of drying them around a drum holds out fairly well, but after a few days these prints also curl. Will you please give me a method by which I can obtain flat prints or prints having a slight back curi?-K. R.

A. In a recent assue we mentioned the idea of moistening the backs of the dried prints, placing them judividually between blotters and allowing them to stand in a piess of under a weight overnight Also, a number of solutions are available that claim to guarantee flat prints. Glycerine in the ratio of one to 19 of water has been recommended as a sure cure for curled prints Have you tind using double weight papers? in any event, much can be done to prevent future curling of prints by regularly storing the prints be tween weighted papers, or in a file. One good method, though it may be bothersome and expensive, is the use of Holliston cloth hacking for the individual prints.

Q. I would like a general idea of the cost of developing films at home, com pared with commercial prices. About how many pictures a month would it be necessary to take to make it worth while to do such developing?-G. M.

A. We presume you are referring to the profit possibilities in photo finishing at home, for others, on a commercial basis Although we do not have exact figures, the chances are very much against the likelihood of your

being able to obtain a sufficient monetary yield over and above the cost of production to make the proposition worth your while It is well nigh impossible for an individual working at home with ordinary equipment to compete with the large photo-finishing houses. The 1810 - are much too low, for one thing, and an individual cannot turn out the large volume necessary to bring in a suitable reimn. Other factors militating against the idea include the difficulty of turning out the negatives on the 8 hour lusts. the posture of pick-up and delivery, and so on. Production on a large, steady basis is the keynote of the commercial photofunding houses, and production is the one thing the home finisher is not equipped for

Q. I am using three Correx tanks and a 312-minute developer at present. The time required to pour in and pour out the developer is apparently giving me over-developing to some extent. Ques-tion No. 1: If I added 1000 ee. of water to 1000 cc. of, say, a 31/2-minute developer, could I figure that this would give a 7-minute developing time? Question No. 2: Can you suggest any way to get the most out of a thin negative for dispositive printing to prevent too much contrast? I have several hundred handcolored photographs and as many more colored by a commercial process that I am desirous of copying on Koda-chrome, Question No. 3: Have you any suggestions as to the use of "mats" to place around these colored photos in order that an exposure meter may be used, thus saving time and material? I'd like to ask the same question regarding black and white. Questlon No. 4: In March Scientific American you answered a question relative to copying articles from journals. You spoke of a new type of frame to hold magazines or books while doing this work. May I have information on the construction of this frame and where it may be purchased? Question No. 5: Does a p of sheet glass interposed between print-ed matter or a photograph and the camera lens require extra exposure as camera tens require extra exposure as a rule? Does it give trouble from re-flected light?—F. T. C. A. No. 1: Dilution of the developer may

work out as you suggest but not all declopers will work out in this way and the hest procedure still is to follow the manulacturer's processing instructions. You may jugze on a duration of about one mainte for pouring developer into the tank and one numite for pouring it not signa, thus allow ing one minute and a half for development in the tank.

No. 2. Intensification of the negative by chemical means as probably the most effective method, permitting the intensication in proceed for the animum person required to produce a printable negative. If the negative is not bin, a medium had grade of paper contrast will give sinishly results apping a yellow hiter over your enlarging bins sometimes is useful in pointing from thin negatives.

No 3 A black frame of paper or card heard with an opening just large enough to display the picture is all you will need Illianmate the subject evenly from both sides, each light approximately at an angle of 45 degrees to the plane of the subject I se a meter of the so called visual extincnon type and point the meter at about the center of the nictore and at a distance from the subject equal to the shortest side of the picture. At this distance you will cover an angle that will include the picture only and nothing else, thus giving you the correct exposure. In view of the extense of the material you are using, we would suggest that if the colored photographs are some what equal in brightness, you make a series of exposures of one of the pictures, pulling the slide of your film holder up about an meh at a time (We midustand you are using a 9 by 12 cm camera for making these color copies) Send this one Kodachrome for processing, and when it is returned you can select the proper exposure for the subnet and the particular lighting set up. Concrining black and white comes, the same highling and exposure routine as for color may be employed However, if you are to copy colored photographs on black and white film stock, it may be necessary to use a filter, perhaps a dark yellow

No. 4: The frame item to which we referred was merely a general suggestion on the constitution of such a frame; the frame is not commercially available

No. 5. The use of glass in cularging or contact printing is standard procedure. Therefore, you may employ it willout hestnation. It will not give any trouble due to high reflections.

O. What is a good way to label darkroom bottles without having the lettering wash off in time?—D. L. O.

A. Every phongrapher has his own pelway of identifying bottles in his darkroom. One ingenious method we recently heard about involves covering the desired purious of the bottle with solforce and (LP), then writing on the spare with a blomt piece of aluminum. The ard is then washed off, and silvery letters are the result. This effect is permanent.

Q. In using an ename! ferrotype plate it notice that, when prints are dried, a slight raised outline of the print is left adhering to the plate which I cannot remove. This raised area sometimes is the suitre paper area and is sometimes confined to the central, more slowly drying

area. I would appreciate any information regarding this condition.--O. B.

A. The condition you refer to is probably caused by the presence of calcium or other impurities in the wash water need for washing the prints. We would suggest that before laving the grains down on the ferrotype plate, the prints the swabhod with a vescossponge, moistened absorbent cutton, or other soft material. We presume that the ferrotype plates are thoroughly of any d with the following plates are thoroughly of any d with the following plates are thoroughly of any d with the following plates are thoroughly of any distribution of the prints are

Q. Is there some way to quicken the drying of negatives after they have been in water for an hour or so? I have used the sun and the wind on certain days to do thus, but this is not a dependable source.—E. M. W.

A Quick diving of negatives can be effirited by sudking in two successive balls for first dipt sudking in two successive balls and of including the print from ordinary commerial type) continuing 10 percent of water, and placing in a current of air. The wind outdoors not outdoor, so to up with a six products of the print of the two distributions of the west consistent of the west consistent of the print of the latter most drops.

Q. Is there a way of getting distortion under the enlarger without having to tilt the easel and thus necessitating the use of very small lens stops and long exposures?—S. E. L.

A. Some time ago a professional photographer space of using a very special kirs for the purpose of elongating the image under the collagar. Recently, a kirs of this type has been commercially introduced by the special control of
Q. In pouring dre chemicals out of formulae in can into the made-up formulae in cans into the the made-up formulae in can at the mouth of the can cause a distinct of the can cause a distinct article to the material so that the themse walls of the graduate that is the inner walls of the graduate that of the can distinct of the can into the graduate that of the grad

A. We have discovered that the best way to do this is to use an ordinary makeshift paper "funnel" shaped like half a cone. Chemicals poured down this "chute" will, if it is appropriately held, but the center of the water in the graduate.

Q. Will you please give me the formin for an effective way to stop leaks in darkroom sinks?—L. B.

d. There are everal methods (nor we head about recently seems to do the job with complete efficiency. The formula calls for 34 parts of apphalt, 25 parts of kerosene, and 40 parts of ableviou meal. Dissolve the asphalt methods the Kerosene. Then pour the asheation powder in a little si a time until you get a stiff putty. This will provide a paste that will prove fully waterproof and do the work.



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Bigs 18 the latest steamlind addition to the popular lane of Bodillas 25 mm minimums it is remarkably third and compact yet is a precision instrument in extra some of the world Among list many features 18 a both-in many features 18 a both-in many features 18 a both-in many features 18 a both-in-in many features 18 a both-in-in many features 18 and particular pa

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The Dolling "0", equipped with Certar f'45 tens in Varlo type shutter (speeds 1 25, 1.56, 1 108 sec., both and time), lists at only \$19.50 with Cortar Anastigmat 5/2 9 lens in Compute 'B'' shutter, only \$29.50

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TUBELES's and re-embling some fanctial creature from Mars is a unque skeleion Cassegnaina telescope (Figure 1), hult by horace E. Dall, 166 Suckingstone Road, Luton, Bedford-bure, England In addition to the tubeles farture it has the spherical secondary mirror, with primary figured to match it, which Dall described several years ago, cally in these columns in June, 1938. At our request Dall with

"Enclosed are photos of my weird-looking 15½" "modified" Cassegram telescope— 'tubeless' yet framed by steel inhes. It has



Figure 1: Dull's polypedalian

turned out to be optically entirely satisfactory and will do utilitiate 1812; can do, and that it as most confortable manner, It is modified not alone in respect to the splenical secondary—this is the least important modification. You will read that I described briefly the main features of the proposed alone in the Journal of the British in 1852, and on the Journal of the British in 1852, and of convenience I repeat the description.

"Manuly, it consists in the introduction of a high-grade intermediate lens tereting lensify on like) between the secondary mirror 1, Figure 1, and the final image For convenience, compactiness, and so on, this lens is supported by a tube 2, through the primary perforation. The benefits resulting from the addition of this lens are very great and he in many directions.

"(1) It couldes the sky-flooding displaragin to be moved from the eyopont (where it is nothing but an infernal nusance, has to be inted to each eyopone, and is almost impossible to keep in good adjustment because of its munit aperture) to a position between erecting lens and eyopoce where it is quite out of the way. It has a large aperture and always keeps in optical alliencent. This occurisk:

"(2) Wide-field eyepieces with comfortable eyepoint, greatly appreciated by spectacled observers.

"(3) A good iris disphragm to be used for

the sky stop just described, so that the aperture of the telescope can be varied by a small index leser (as in the case of my 15½") from full aperture down to nothing. This can be operated while aethally ob-

"(4) Location of the erecting lens between the mirrors enables the long focus of the normal Cassegram to be shortened down to a very convenient length—an important feature of this 15½." I can secure the advantages of variability of the distance between lens and even day of the distance between lens and even distance and distance days of the distance between lens and distance days of the distance days of t

"(5) A final image varying in angular aperture from f/10.5 to f/26. This enables me to get a continuously variable power

over a range of 1.2½ from each eyepiece, "(6) To accommodate any small thermal arrations of spherical aberration of the primary liv opposing the aberration introduced by varying the tinbe length from the mean position for which aberrations are nil

"(7) It erects the final image, permitting excellent terrestrial views of great brilliance and completely free from any sky flooding troubles. I have a fine outlook, terrestrialls, from my observatory and find 1 can take full advantage of this innusual terrestrial aperture at all steady are periods, evening and morning, when air clarity is reasonable.

"In the case of the 15½" my retering these is 2½" in aporture and enables me to have an eyepteer, 3, of lowest power 1500 of real RTF Character, which well include the whole Moon and a large margin to paper. This is probably unbrand of in a 15½" ordinary Cassegran and I get it with a central obstruction of only 20 percent of the primary diameter (4 percent of the light).

"The fully illumnated field v almost 0.3 degrees, but could not not notechle at the odger of the low-power rypueces. In order to get this, of ourse, the cretical lens is somewhat difficult and took me longer to make than the primary. Good cortections make than the primary flow of cortections make than the primary flow of cortections are obtained by ementad triplet construction and the residual secondary spectrum in the final image is quite negligible and wishle only to a practiced ever.

"I calculated the eccentricity of the ellipsoidal primary and did the final figuring with the pinhole at near focus and the k-c at remote focus, some 120 away, the whole being quite convenient and easy. This method is the one I have always used for my splictrial secondary Cassegrains.

"The driving clock, 4, is a Synclock weighing little more than ½ pound all told, and giving ample power even when I am pulling the telescope backward against the independent friction drive (between the polar axis trunnlons, 5, 5, and the worm

"One great advantage of such a small motor—probably the smallest ever attempted for this aperture telescope—is that there are only one or two watts of heat to dissipate and the chance of warm air trouble in the

observatory is thereby very much reduced. "I had intended to put a pair of deflector sheets V-fashion below the optical cones to guide any rising warm air out of the optical paths, but have not yet done so-the need is not extreme, but I think it is destrable, I am certainly not troubled with tube currents, and it seems to me when comparing performance with my earlier 14", open-air, square wooden-tube reflector, that I am decidedly better off now The observatory, shielding the instrument from rapid radiation, helps a lot, despite statements I have sometimes heard to the contrary. The observatory is aluminum painted to retard rapid changes of temperature due to radiation, as per my British Astronomical Association Journal article of January, 1938

"Focusing is done principally with the little handwheel, 6, and extension shaft which moves the secondary, although additional spiral sleeve focusing can be done at the eyepiece end

"The mirror lid is hinged and fastens back on the framework where it is out of the way (shown better in Figure 2)

"To save making up a new stand, all the lower part, 7, is an old Culver equatorial



Figure 2: Close-up of mounting

stand (date 1882). It organally carried as \$M^*\$ muror in nor tube hetwen the trunmors but, as I couldn't get a 15½ between the same trunuons. I carried it to utules and put lead balance weights, 8, 8, on the obseside. The overlang is thus more than onewould use from unfettered choice, but the whole system is very light—much lighter than the original 8½° Calver. I have added worm drives on the two aces, but I show yet to add circles and a few other improvements.

"The finder, 9, is 3" in aperture and the power 10X, with an actual field of more than 5 degrees.

"The photo shows the little clock, 4, but barely shows the RA worm wheel and the



Figure 3: Dall and observatory

anti-friction rollers, 10, which I have added at each end of the 215" polar axis to reduce friction due to the polar tilt. These rollers are spring loaded and press up on the upper and down on the lower roller, respectively, with a force equal to the calculated gravity forces. A hall race takes the thrust down the polar axis.

"Other details, 11 is a handle for moving the telescope, 12 is the screw for slow motion in declination, 13 the switch for drive. and 14 the connecting box, 15 are bright and dim lamps on the dome, and nearby is the dome drive shown in Figure 4

"The observatory (Figure 3) is 12' x 12' over the brickwork base, the dome being 11' 6" in diameter, with 20 ribs Except for



Figure 4: Dome drive and hearing

the mechanical parts, it was planned and built largely by Perry, a neighbor. The wheels attached to the wall, or fixed base, of the structure. The ash rail, which shows as a broad band traversing Figure 4, is on the dome-Perry's idea. This saves a lot of work. One of the skate wheels shows in the extreme right in Figure 4. It is mounted on a bell-crank arrangement-a triangle of iron pivoted at its upper right-hand corner. Attached to its lower corner and to the ash rail is a tension spring from an old meshtype bedspring. These springs insure that each roller carries its due share of the load, within a few percent-practically impossible with fixed rollers, Incidentally, the observed deflection of the springs in a gale enables me to judge the direction and amount of the forces due to the wind.

"To the left in the same picture is the motor drive for the dome: gears and a rubber-faced wheel. The drive is by friction and works nicely.

"The shutter of the observatory dome has a 36" opening. The flat part of the roof is covered with copper sheet.

ADDENDUM to note on ruling engines for diffraction gratings, in "Amateur Telescope Making," page 466: In an article on Prof. Michelson, published in The Scienti-

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THE BEGINNER'S CORNER

PHOTOGRAPHY of celestial objects, especially the Moon, is one of the simplest and usually one of the first stunts performed by the builder of a telescope. The book "Amateur Telescope Making" con tains definite instructions for doing it, and the equipment needed consists simply of the regular eyepiece used in visual work, to which are added some kind of box and a simple photographic plate.
On this page are shown three amateur-

telescopes thus equipped The first is a 6" reflector made by Charles E Kraiz, 3415 Copley Road, Baltimore, Md., who states that the camera is made of two telescoping wooden boxes, the stationary one curved to fit the tube to which it is fastened removably with hooks. The sliding part has a film holder or, alternatively, a ground glass focusing screen. (Anyone who has made his own mirror will know how to make ground glass, simply by brief abrasion with mediumsized abrasive grains.) Kratz' telescope is mounted on 3" pipe fittings and he says there is no shake.

The second telescope is similarly equipped and, having a worm drive, can be used for photographing the stars as well as the

Moon. A. R. Karnosh, 3296 Lansmere Road. Cleveland, Ohio, is the maker.

Third telescope is the work of R. M. Watrous, M. D. and Mrs. Watrous, and is the mate to the one shown here last month, though built a little more solidly. In the Watrous telescope the same box that is used for photographing the Moon by means of the telescope may be detached, remounted as shown in the fourth photograph, a lens added, also an end to hold it, and used for direct photography of the stars. Dr. Watcommon 1/4" plate glass and, that, though there are strike in the glass and though it is, naturally, subject to every type of aberraform images—of a sort. A photograph of a part of Orion, taken with it, is reproduced.

The two planetary photographs were made hy H. A. Lower of San Diego, Calif., with more elaborate equipment but on the same simple principle, The first is of Saturn, exposure 30 seconds, the second of Jupiter, exposure 15 seconds. Much original detail -most of it, in fact-has been lost in the half-tone process. The lunar photo was made by B. L. Bradley, 235 N High St., Salem, Oregon, and is typical of many that have been sent this department. Unfortunately, the half-tone process reduces them all good, bad and indifferent-to the same level of mediocrity but many of the orig mals received are very sharply defined









TELESCOPTICS

(Continued from preceding page)

fic Monthly, January, 1939, Prof. R. A. Millikan says that in 1900 the former "turned his attention to the problem that gave him more trouble and at the same time filled his associates with more admiration for him than any of its predecessors had done; namely, the problem of ruling very high resolution gratings. He had thought he could huild a machine in a few months, or at most a few years, which would give him the desired resolution, but he spent the rest of his life without reaching the point at which he was willing to drop the problem. He often said he regretted that he ever 'got this hear by the tail,' but he would not let go, and, in spite of endless discouragements, at the end of about eight years of struggle he had produced a good 6" grating containing 110,000 lines.

Undoubtedly the note in "ATM," mentioned above, failed to lay enough stress on the supreme difficulty of this problem and a number have planned, therefore, at various tunes within recent years, to undertake the job For this, your scribe blames himself in large measure. This is not to say dogmatically that the amateur cannot succeed, but rather to point out the worst; namely, that the job is tough, tough, tough. It was tough even for Professor Michelson, and he was the physicist's best exponent of the methods of ultra-refinement and precision, having a marked native flair for pushing these characteristics to their very atmost. Yet this piece of work took him eight years. hence the amateur, if he undertakes it. should not do so lightly.

The ruling engine as a whole is a nice piece of instrument building but it contains one item that goes far beyond ordinary or even extraordinary varieties of nicenes the lead screw, its very heart. Making a screw is not a hard job but freeing it from errors-there is the rub. A fair glimpse into the nature of this cantankerous, pernickety job and, in fact, the only glimpse your scribe has ever been able to find in print, is contained in a slx-page illustrated article in the June, 1917, number of Ma-

chinery (New York) Its title is "Making Precision Screws for Scientific Instruments, and it is based on the method as used by (saertner First, the screw is made as good as can be by ordinary methods. The job has then just begun. With a special lathe and -pecial equipment-in other words, a lot of construction has to be done before the screw an even be started—the high places doe to irregularity are shaved off, leaving smaller



Figure 5: Fringes, warped flat

high places. The operation most be viewed with a mirroscope if the extremely thin cuts are to be seen at all, for the naked eye alone seems to slow that the tool is not in action at all The smaller remaining high places are again shaved off and the sano process carried to finer and finer residuals The remaining steps are too lengthy to describe here. One is the testing, which is done with an interferometer, It takes the observer one month merely to test the accuracy of a screw 3%" lung. The article tells how all this is done, but not how to do it Prohaldy no article can do that One playcist, famous for his gratings, told your scribe that, of a man had of in him he would not need women instructions, while if he hadn't be wouldn't be likely to get to first hase with the most detailed instructions Sounds cynical but is probably about right Not, however, that this will scare off the aspirant-see what Porter says, in "ATM," page 651

"COME may find it difficult to make a Ronthi grating, as discribed in AFM, page 266, by threading the edge of a loass france, and then winding it. I found that the sharp edges of the frame cut the fine wire How ever, no thread is meessary I made two gratings, using No. 40 enameled wire (at my tadia store) The brass frame should have rounded edges and he carefully chucked in the lathe between centers. Mount a sine ple guide in the tool post, so that the wire is fed to the frame when it -the frame-is vertical. Set the feed at alount 150 to the inch, and wind the wire on with slight tension, Before removing from the lathe, paint the edges with Daco coment and a fine camel's hear brush When div, put a thick layer of liquid solder on one side only, and when dry, cut away the were on that side with a razor blade. Do not attempt to cement the other side, as the wires are easily disturked "-- A note contributed by Cyril G. Wates, 7718 Jasper Ave., Edmonton, Alta.,

STRAIN-warped surfaces on a flat ex-plams the pattern of interference fringes shown in Figure 5, two photographs sent us by Horace H. Selby, author of the ne-structions for making flats in "ATMA-They represent a 12" flat on an 8" disk and the chief symptom is lack of parallelism of the fringes. The appearance is exaggerated in the right-hand photograph, where the fringes are more widely separated.

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SUCCESSFEE FINE-GRAIN NEGATIVE PROCESSING gives briefly the facts about devel opment and how a developer should be chosen and used to insure fine-grain results. Raygram Corporation, 12: Fourth Asenue, New York, Coty.—5 cents.

STRAGIT SHOULTS, is a 14 page pamphlet, that tells how to handle and care for firearms On the first page is pre-ented "The Sportsnen's Code," which if followed will do much to promote safety in the handling of gains. The brief but complete text is supplemented by a series of informative photo graphs, Marlin Firearms Company, New Husen, Connection 40 cents.

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Done 5 vo Divisi, a booklet that presents a description of the modern Direct origine, what it is and how it operates a compared with the conventional gashine engine. A number of drawings make the text per feetly clear. The booklet was motivated his the recent introduction of a Direct-powered thereton truck for heavy-duty ws. It will give a wider spread to an understanding of Direct Operation and advantages, Dodge Division, Christer Corporation, Detroit, Michigan,—Cantil.

NYMA STANDARDS AND DEFINITIONS is an 8page blooklet which includes suggestions for the proper selection of electric motors and types of drives. Information is also given regarding service factors and rated loads, that will be of value to anyone who buys, specifies, or maintains electric motors. Request Bulletin No. 610. Advertinang Department, The Louis Allis Company, Milswoods, Fisconia—Cratis.

MAKING UP FOR THE CAMERA is a 14-page booklet that tells how the photographer, professional or annateur, can obtain the best results in portraiture by having his subject use the correct type of make up. Miner's, Inc., 12 East 12th Street, New York City.—3 cenis.

LEGAL HIGH-LIGHTS

Patent, Trade Mark, and Related Legal Proceedings That May Have a Direct Effect on Your Business

By ORSON D. MUNN, Litt.B., LL.B., Sc.D.

New York Bar
Editor, Scientific American

UNAUTHORIZED

YOU may engage in the business of reand you may indicate in your advertising the type of automobile that you repair even though you do not operate an authorized service station. However, in so doing you must not represent that you are the authorized dealer or secund the manufacturer.

In a recent suit, the manufacturer of a well known automobile brought suit against the operators of a garage or service station on the grounds that the sign that they employed created the impression that they were authorized agents of the automobile manufacturer when, as a matter of fact, they were not anthorized dealers or agents. In the case in question the garage operators employed a sign bearing, in large block letters, the name of the type of automobile which they repaired The court found that in smaller letters beneath the name of the automobile the sign contained the word "repairs" and the legend "We . . . do not act as authorized dealers The defendants contended that the qualifying words as set forth above indicated that they were acting in good faith and that they were not trying to represent that they were authorized dealers or agents of the manufacturer. The court found, however, that the name of the automobile was the prominent feature of the sign and that the qualifying legend was relatively obscure and was not "consistent with the good faith asserted for the defendants" As a result the defendants were restrained from displaying a sign bearing the name of the particular automobile unless the sign made it clear in equally prominent lettering that the defendants were not the authorized agents of the manufac-

ART PATRON

WHERE an artist contracts with an art patron to execute a work of art the artist is not entitled to obtain a copyright on the work of art, according to a recent decision.

In the case in question an artist was restained by the City of New York to execute two mural paintings in one of the New York City high schools. The contract providing for the execution of the murals was silent as to the ownership of copyrights. In spite of this fact, however, the artist subsequently obtained a copyright on each of the murals.

Thereafter, without the permission of the artist but with the consent of the City of New York, appublisher reproduced one of the mural paintings in a history book. The artist had died and sult was brought by the

artis's sister against the publisher for copyight infringement. The suit was dismissed
by the court on the grounds that the art
patron, which was the City of New York
rather than the artist, was entitled to the
copyrights on the murals and that accordingly the artist and his next of kin held the
two copyrights which were obtained in trust
for the Caty of New York.

In this connection the Court stated—"When a man, hiremafter referred to as a patron, contracts with an artist to paint a picture for him, of whatever nature it may be, the contract is essentially a service contract, and when the picture has been painted and delivered to the patron and paid for hy him, the artist has no right whatsoever left in it?"

WASHED UP

THE use of the tade mark "Cablern" on Leisung and Blesching compounds has been restrained on the grounds that it is an infragment of the trade mark "Clores" The manufacture of a clean-sing and blesching compound of antisepher character identified by the trade mark "Clores" brought sun cagants a computer is much great trade mark "Chlorn," charging trade mark infringement and also indirer competition.

It was contended by the defendant that the name "Clrox" was not a good trade mark and that it was descriptive of the plantiff's product same the product contained sodium carbonate and sodium hypochlorite, the later bring a compound of chlorine. The court rejected this contention and held that the mane was arbitrary and function and accordance was always and function and accordance was the production of the parties and concluded that an injunction should be granted. In this connection the court stated:

"The selection of the word 'Chlorit' was not a mere coincidence. It was a deliberate is heme on the part of the defendants. Fortunately a Court of Equity can extend its arm to protect the planntiff in the use of the name 'Clorots'."

EARTHOUAKE

E ARTHQUAKES were involved in a recent suit for patent infrangement. The usit was brought against a school dustrict of Los Angeles County, California, for mfringement of a patent relating to the requake. The patent disclosed a method for paparing whereby the damaged wall of the building was permitted to stand and a new wall was erected adjacent to and outside the damaged wall. The Court found that, prior to the patent in sul, damaged buildings had been repaired by erecting a new wall inside the damaged wall. Under the old method roofing or flowring josts were carried directly by the newly erected wall. In the patented method it was necessary to provide ledge-like projections on the newly erected wall to support the josts, since the new wall was disposed outside the damaged wall.

It was contended by the patentee that creeting the wall outside the damaged wall rather than inside and providing the ledge-like projection to support the joists constituted invention. The court in rejecting this contention stated

These, we think, are immaterial difference. That a new wall, designed to reinforce an old wall, may be erected on either side of the old wall is, and must always have been, perfectly obsions. Equally obvous is the fact that, if a new wall, cerected outside an old by the old wall, and such points do not extraor distribution of the old wall, and such points do not extraor distribution of the old wall, the new wall must have just-importing projections extending invarially of the old wall.

DELAYED DEPOSIT

UNDER the heading, "Procrastination," in the December, 1938, issue of Scientific American, we discussed a sun for copyright infringement in which the Court lied that a delay of 14 months in depositing copies of a copyrighted literary work prevented the copyright proprietor from mannang suit for copyright infringement.

In the case in question the publisher of a monthly magarine had affixed a notice of copyright to one of the issues of the maga ane but had failed to deposit copies of the magazine will the Register of Copyrights until after a lapse of 14 months. In the meatures a look publisher had publisher had publisher had the copyright of the copyright of the copyrights of the copyrights the brought suit for copyrights the brought suit for copyright of the copyrights the brought suit for copyrights the property deposited the copyrights the brought suit for copyright of the copyright.

Since there was a delay of 14 months in depositing the copies the lower court held that the provision providing for prompt deposit had not been complied with and accordingly that no suit could be maintained The United States Supreme Court reversed the decision of the lower court, holding that a copyright was obtained by publication of the magazine with notice of copyright and that as long as the deposit of copies was made prior to filing the suit, the publisher of the magazine had complied with the statute. One of the determining factors in the Supreme Court decision was that another provision of the statute provides for certain penalties if the copyright proprietor failed to make deposit after a demand by the Register of Copyrights. Since the statute did contain a penalty provision it was ar-gued that in the absence of the application of the penalties provided for, the statute was sufficiently complied with when the de-posit was made prior to filing suit.

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EDITORIAL STAFF · ORSON D. MUNN, EDITOR ALBERT A HOPKINS F D McHUGH A M TILKEY
PROFESSOR BENEY NORRIS BUSSELL FOR PROFESSOR ALEXANDER KLEMIN

CONTRIBUTING EDITORS

CHURCHILL EISENBART. Department of Maine-matics, University of Wisconsin Statistician, Wisconsin Agricultural Station

Wiscossin Agricultural Station
MORRIS FIRBERIN, M.D. Editor of the
Journal of the American Medical Association
and of Hyper
MILLIAN & GREGORY. Professor of Yeria
brate Palconilogy, Columbia University
LEON A. HAISMAN, Professor of Zoology,
New Jersey College for Nomes. WALDEMAR KAEMPFFERT, New York Times

D H. KILLEFFER, Chemical Engineer. IRVING LANGMUIB, Associate Director, Re-search Laboratory of the General Electric Com-pany, Schenectady.

F HUFELNAN Jr. Interfor Bleeserb, M. LUFKEBH, Director, Lighting Research Bendington Affecting and Mussu.

L WARRINGTON CHURB, Director of Research Laboratories, Westlandpose Beterit and Mussu.

JACOB DESCRIM, Antatur Photography

CHURCHILL ERESKART, Department of Mather.

BOY W MINER, American Mussum of Natural CHURCHILL ERESKART, Department of Mather.

Ristors
RUMBLL W. PORTER, Associate in Optics and Instrument Design, California Institute of Technology,
W D PULESTON, Capitain, United States Navy
J B. RRINE, Associate Professor of Psychology,
Duke University, Chairman, Research Conmittee, Booton Soriety for Psychic Research.

mittes. Bosion Society for Psychic Bassarch, PHILIP H BAHTH, Houstrist Research, R. A. WILKINS, Vice President and Director of Research, Rever Copper and Brass, Inc. Research, Rever Copper and Brass, Inc. Johns Hopkins University, Victor Houston, Johns Hopkins University, VIADMIR K. WORTKIN, Director Rectronics Research Laboratory, RCA Manufacturing Company, Victor Division.

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For MEN

who want to become independent in the NEXT TEN YEARS

IN the Spring of 1949 two business men will be sitting in a mid-town restaurant. "I wonder what's going to happen next year," one of them will say, "My business is fine now-but the next few years are going to be hard ones, and we may as well face the facts."

The man across the table will laugh,

"That's just what they said back in 1939," he will answer. "Remember? People were looking ahead apprehensively-and see what happened! Since then there has been the greatest growth in our history-more business done, more fortunes made, than ever before. They've certainly been good years for me."

He will lean back in his chair with the easy confidence and poise that are the hallmark of real prosperity.

The older man will sit quiet a moment and then in a tone of infinite pathos:

"I wish I had those ten years back," he will say

· Today the interview quoted above is purely imaginary But be assured of this-it will come time. Right now, at this year hour, the business men of America are dividing themselves into two groups, represented by the two individuals whose words are quoted. A few years from now there will be ten thousand such luncheons and one of the men will say

"I've got what I wanted." And the other will answer:

"I wish I had those years back."

In which class are you putting yourself? The real difference between the two classes is this-one class of men hope vaguely to be independent sometime: the other class have convinced themselves

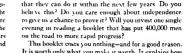
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The same has been true of hundreds of other manufactured articles. Because the scientists, engineers, and workmen of industry have developed hundreds of new products, have continually improved them, have learned how to make them less and less expensive, more millions of people have been able to buy them. And by this process, industry has been able to provide the American people with the highest standard of living in the world.

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O LR rover this mouth is an artist's conception of the new North Caroline class of health ships being huth for the United States Nury. From the unmound maple almost beneath the grace-ful clipper bow, our nitist has captured a feeling in power and speed as well as shown a number of the important features of these ships discussed by Dorar Parks; in the article beginning on page 351. See also Dr. Parks; drawing of the North Caroline on but page.

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OUR POINT OF VIEW

Destructive Taxation

THE publishers of Scientific American have rarely presented in its columns discussions of either political or legislative nature. In view, however, of the confiscatory terms of Senate Bill (S 1885) known as the War Profits-Tax Bill, and the fact that most of the daily press has discussed the Bill only in a brief manner, we feel impelled to present to our readers some of the specific terms of the Bill, which if enacted into law, would, in time of war, stagnate industry and pauperize the tax-payer. We do not recall any proposed legislation emanating from our elected representatives which could be more harmful to the well-being of our country than the Bill under consideration, and it is hard to conceive why such a permeious measure should receive serious consideration by our legislators.

Bill 5 1885 would apply the following scale of income taxes to the individual: the normal tax would be increased from 4 percent to 6 percent and a surtax rate of 10 percent would be imposed on incomes between \$3000 and \$5000 Therest \$1500 of net income would carry a surtax of 30 percent; the following \$1500 income would be taxed at the rate of 50 percent; the surtax rate on the next \$12,000 would be 70 percent; and all net income in excess of \$20,000 would be taxed at the rate of 50 percent.

If this Bill should be passed, corporations will be strangled by the imposition of a tax which is intended to limit therprofits in time of war. Computation of the tax will be based on the declared capital stock values as of the year 1934 as adjusted to the end of the calendar year preceding a war declaration. Income up to 2 percent of adjusted declared value will be taxed at the rate of 15 percent; over 2 percent and not well carry a tax of 25 percent; all corporate income in excess of 6 percent adjusted declared value will be taxed at the rate of 100 percent.

Space does not permit a full discussion of those features of the proposed Act which include a burdensome tax on undistributed profits, the filing of quarretly returns by corporations, and the length of time nor which the tax becomes effective. Neither can we go into detail regarding the personal exemptions which would be so dressically reduced as to approach the vanishing point.

It is said that 50 Senators have approach the vanishing point.

It is said that 50 Senators have approved 'the War Profits-Tax Bill. and while that fact does not assure its passage, the sax-payer should take every precaution against the possibility of the Bill's approval by procuring a copy of it and filing strong protest with his Senators and Congressmen —O. D. M.

Fewer Farmers

SOME people did not even know that of the country has changed from a nation of farmers into one composed largely of city workers. Those who did know this fact knew it in a general sort of way only and probably never did magnes the proportion to be; one fifth in agriculture and four fifths in city work. Few ever gave much thought to the metamorphosis or the reasons for the reasons

Sensational headlines are, therefore, undeated. Yet the Department of Agriculture recently announced quite casially inno ed its press notices: "Why Caty Workers Outnumber Farmers." Not that we go in for glaring headlines or melo-transitie eye-catchers. We don't, But here is a subject to be picked up by the daily press and given life and color betting its importance in the American scheme of things. For, linked inseparably to it, causing it, and benefiting by it are American democracy and the gentius that made us great, Yankee ingenuty and the ploneer spirit, and the profit motive in free can be profit motive in free can be profit motive in free categories.

Reapers, gins, combines, corn harves; rs, ractors, and hundreds of other laboisaving devices have given greater farm production with fewer farm laborers. At the same time the expansion of industry has provided more jois in and around cities. Improvements in distribution and processing have done their bit by assuring the farmer that a larger percentage of his produce would reach the market anspoiled or would reach a more favorable, distant market, and then, perhaps, be processed into new forms.

Technology and invention made possible or caused—depending on one's way of looking at it—this change in a nation's working habits. That, too, may sound matter of fact; yet it takes not even an intelligent imagination but only a knowledge of the facts of history to see bound up within it romance and heart-break, achievement and hardships. Farmers, themselves, provided many of the devolopments that have improved our farming methods. Others who were primarily inventors supplied many inventions. But research workers, industrialists, men with vision to see possibilities and courage to carry through have done a larger job in developing correlative services, industries, processes, and markets. Struggle has been the keynote of the efforts of all these, and some have, indeed, suffered discouragement and poverty Yet out of their work has come, not simply fewer farmers and more city workers, but an enormously improved standard of living —F. D. M.

Toward Conservation of Wasted Power

JUST as the Emily Posts of good etiquette and best breeding have practically completed the diplomatic isolation and military encirclement of that ill-mannered, all-American habit of chewing gum with the mouth wide open, the science of psychology has extended to gum chewing full diplomatic recognition and an alliance. In a paper learnedly entitled "The Psycho-dynamics of Chewing," Professor Harry L. Hollingworth, Columbia University psychologist, has announced the results of four full years of research on unnerous chewing and non-chewing subjects, to prove to us what we already knew-that gum chewing raises the energy quotient of the chewer He found that writers, for example, pressed harder on their pencils, while typists typed faster. Nervous tension decreased and habits such as foot tapping drained off through the gum.

Without Emily Posts permission we have been pecking into Department of Commerce statistics on chewing gum, and we find that the industry has 26 establishments employing some 2300 workers, uses about \$15,000,000 worth of materials—chiele, crude gum, sugar, corn syrup, flavoring—in making a product having an annual value of about \$50,000,000 Some \$75,000 worth of cleetrical energy is consumed and this represents the first or primary gum industry; what of the second?

The \$50,000,000 annual product value, divided by five cents, the price of a packet of gum, represents roughly a billion purchasee containing about ten billion chews. Allowing three hours per chew, and assuming the brake horeepower of the prime mover at, say, one thiriteting (although some we see look more like a full horsepower and often sound like ken), we arrive at something like one billion horsepower-hours of power generated the nation over, each year. The primary gum industry isn't a patch on this, the secondary one!

Who now will find a way to collect the wasted gum-power, return it to the gum manufacturers to be used in making more gum to release more gum-power, and so on and on—a regenerative feedback, almost perpetual motion!—A. G. I.

$50~{ m Years~Ago}$ in \dots

SCHENTOPKC AV MOERICAN

(Condensed From Issues of June, 1889)

PIGS IN CLOVER.—"The value of futle myntrous has had a superlar proof or nanitestation lately in the great run on Pags in Charge a puzzle that has, we wenture to say, been seen by nearly all our readers, for it has already made its way everywhere. Three hundred gross have been turned out daily for some time, while the demand has not yet been met by the supply."

AIRSHIP—"An airship designed to be completely under the control of the operator, and to be easily secret and popelled in any direction, with, on, or against the wind, is shown in the accompanying illustration. The most prominent feature of the construction is a balloon made in three compariments, the lower one stiffered by a



franework and supporting the second compartment, on which is secured the third compartment, exposed to the action of the wind, and with its edges attached to the framework, A closed basker, the interior of which is partly slown, is supported on the under do of the balloon, and contains a motive power, preferably in bicycle form, for operating sidewise flapping unique and central wings."

TIES—"Assuming the entire railroad system of the United States to be 160,000 miles, as appears from "Poor's Manual," with the addition of the lines in construction during the entrent year, and taking 2640 tres per mile of track, we have in use at least 422,400,000 tres. This estimate, larger though the total appears, is under the mark, as no railroad uses less than 2610 tres per mile, and many of the toods with the virt raffic have 2816, and in a few cases more."

HOBBIES.—"said a genileman who had seen nucle of human lifand was himself an enthusants student at three-core years." No unan in this world can be happy without a hobbly—indeed, for diverting our minds from the blutte crosses which we all have to bear, there is no earthly oblice we healing as a subject in which we are intenedy, interested—something to which the thoughts may any noment ricin shem werry of the suggestions we would escape when, in addition to being an immoved diversion, once as a useful who passes through life without being an enthusastic student of something lowes much than the anapprecision."

NEW METALs.—"At the last string of the Russian Mineralogueal Society, K. D. Chrustischoff demonstrated the existence of a new metal which he has just discovered, and its which he gives the name risissium. It approximates closely to thorium, and is one of the hochies whose existence was foreseen by Professor Mendelegiff. We learn also that Dr. Kruss has named the metal which he has detected along, with nickel and cobalt, gnomium?

FLUME -3 it is claimed that the recently completed Sau Diego flame is the most superiolous ever constructed in the world, being only a little short of thirty-six index long . In the course of the flame there are some 315 treatles, the longest of these being 1700 feet in length, eighty-free feet high and containing one quarter of a million feet of limither. Another treatle is of the same bright, and 1200 feet long, the main timbers used in both of three being ten by ten and eight be eight, put together on the ground and russed to their noising his borse nower.

FLOOD—The appulling dessers of the binstaing of the dain binding, back the water of South Fork Lake in Pennylysman, by which Johnstone and the villages and country near at on the main line of the Pennylysman gained were sorp time trans, and in main line of the Pennylysman gained were sorp time trans, and in the main line of the Pennylysman gained were sorp time transparent the great catastrophes of the world. The Juglish speaking race has nearest before been affected by a catastrophe of equal moment. The flood, with the added horons of confligration, was due to the sudden sexans of the waters of our of the furgest artificial lakes in America?

CRUSER—"The Itahan cruses Premoure was described at the menungs of the Institution of Naval Architects by her designer. Mr P Watts During a natural draught trial of four hours' duration, a men speed of 20 4 knots was attained with about 7000 indicated here-power, and during a forced draught trial of one and one half hours' duration, a measured mile speed of 22 4 knots, attained with a mean power of 12700 hourses, the maximum power hoursespook The duplacement of this evened is only 2500 time, visit and carries no 6 inch quick-firing gains, six 4 3 cinch quick-firing gainand a large number of smaller gain.

(ATERPILLARS.—The caterpulars, which are making their tents carlier this year than usual, sowing to the surin spring weight, should be looked after at once. The simplest and perhaps, on the whole, the best way of getting rid of them is to brish off the nest from the trees, as fast as they appear, with a long handled conical-shaped brush.

TRANS GHANNEL—The English are contemplating an idea to lay down a postal tube between Dover and Galass. The plan is to suspend two tubes of about a yard each in diameter by means of steel cables across the channel, fouty yards above the level of the sea. The steel cables with be faced to pillars at distances of about 800 yards, and in each tube a little railway will 11m with cars capable of carrying 450 pounds in weight No parcel of greater weight than this will be taken, and the cost is estimated at the modest figure of 5,000,000 dollar."

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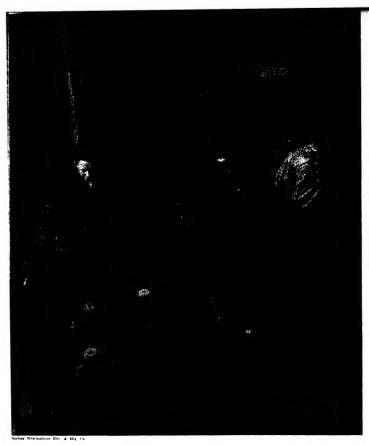
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The "North Carolina," most powerfully armed of all capital ships now building -a fresh note in American ship sithouette

THE FUTURE OF NAVIES

THOSE who have previously read Dr. Parker aval discussions in our pages and studied his telling wastl drawings, will welcome this analysis of naval design and construction programs of World Powers. In the present article, the discusse, the world, and in the concluding part, next month, takes up other categories.

For many years Editor of the justly famous "Jane's Fighting. Ships" annual. Dr. Parkes is respected as an authority by naval men the world over. His entré to navy departments is such therefore, as to enable him to obtain much information unvailable to other laymen. It follows that his opinions bear considerable weight.

We consider ourselves fortunate, indeed, in being able to present his two-part article to our readers. It is one of the finest in a sequence starting, Dr. Parkes reminds us, with our publication 25 years ago of his article on and drawings of the Japanese Kosechi and Kongo.—The Editor.

NOW that the Navel Treaty with its restriction upon numbers, types, displacements, and gun calibers have been terminated, the navel Powers are free to design and arm their ships without let or hindrance, subject only to certain upper limits in battleship tonnage and gun-caliber which have been agreed upon by the European countries; and in a world antagonized, the armanent race is being pursued with the grim intensity of pre-war days although with a dread foreboding in place of national pride in pomp and circumstance. Allready the alignment of forces is

Powers Build Larger Battleships . . . Sizes, Armament, Armor . . . Use . . . Effectiveness . . . Concluding Discussion, on Other Ship Categories, Next Month

By OSCAR PARKES
Associate of Institute of Naval Architects

becoming ohvious Germany, having kicked over the Versuilles traces, is bent upon the formation of a pan-German league which shall dominate Europe, and the recovery of her former overseas possessions for the purpose of creating the necessary supply bases from which commerce can be attacked Italy visualizes a second Roman Empire with domination in the Mediterranean Japan aims at the complete subjugation of China and acquisition of such additional territory now held by European nations as shall make her position secure And behind it all is the necessity for foreign tradetrade assured by the national possession of great markets which may be clused to competitors and sources of natural wealth from which the basic necessities of industry may be obtained without cur-rency difficulties.

N ATURALLY both Britain and France would be content with the status quo, but as the ambitions of Cermany and Italy can only be realized at the expense of these two democracies, they have been compelled to "look to their mosts." America sees the probable lows of her trade in the Far East—the future greater market in the world—with the possibilities of pro-German thouble in South America and must needs remember that she may become involved in defending her interests in both the Atlantic and the Pacific. And so while Japan, Germany, and Italy can plan their forces with the

object of attack, Britain and France must visualize the far more difficult problems world-wide defense. America, having neither overseas posessions to tempt the Have-nots' nor the problem of guarding an ocean-borne food supply, is in thhappere postution of being able to concentrate lure energies upon what is recap nized as the best form of defense.

Ilaving thus outlined the ambitions active or passive—of the Powers, we are in a position to appreciate the composition of the naval forces being amassed by each, and such peculiarity of type or design in the various classes of fighting ships as has been dictated by particular national requirements.

At the present time, history is going through a phase of repetition. Fifty years ago the battleship was popularly supposed to have become obsolete owing to the growth and alleged effectiveness of terpedo craft, and her place was to be taken by fast "protected" cruisers. The later development of quick-firing guns enabled the big ship to assume her rightful place as the prime unit of naval defense Then, for some years after the World War, her pride was again humbled, this time by the submarine and airplane which, in combination, should theoretically have been able to drive the goliaths of the sea into impotent seclusion; but the inevitable development of defensive measures again assured their supremacy afloat, although to a more qualified extent.

Today, the measure of a battleship's powers of defense against air and underseas attack depends largely upon her displacement. Given sufficient beam, a ship can have enough bulges and internal longitudinal bulkheads to withstand several torpedo hits; given the weight of deck armor, she can be made to withstand heavy bomb attack. No ship can be made impregnable, but "the bigger the safer" is a sound axiom, and if very big guns are to be carried as well as an adequate secondary armament, certainly more than 35,000 or 40,000 tons will be necessary-at least 50,000 tons is regarded as the constructor's datum line. With such a displacement, the battleship will become a fantastically expensive weapon, with limits to numbers and an undue national value attached to each-- loss of one meaning a eatastrophe impossible to overcome during war.

Can the monster battleship he replaced by other types of warship-or by air-craft? So far as the British Admiralty is concerned, the answer is in the repaired in the control of the third war in the repaired in the control of the third war in the control of a battleship can be represented by distribution of the third war in the consideration the consideration the consideration the consideration the overhead, maintenance, replacement, and similar charges to make an effective comparison during the life of a capital ship.

Actually, the relative costs of battleships and sirplanes have not, in themselves, any bearing upon the matter If capital ships are essential to security, they must be provided; the advocates of air power would wish that their country should build no more—although other Powers should still continue to build them. If their theories turn out to be well-founded, money has been wasted; if ill-founded, the test of them would result in the loss of perhaps an empirical

How, then, are battleships likely to be employed in future warfare? In the past they were used: (1) on blockade: (2) to cover landing operations; (3) for bombardment; and (4) to bring the enemy fleet into action. Today submarines and aircraft will put (1), (2), and (3) out of court; these duties will be relegated to

lighter craft and the battlefleet will exercise its influence only as a distant covering force But, whereas commerce raiding and convoy protection were formerly essentially cruiser duties, in future hostilities we must be prepared to see battleships let loose upon the trade routes, making the problem of commerce protection increasingly difficult and complicated, Naval warfare will turn more and more upon the attack and defense of merchant shipping, with every type of vessel being employed, the battlefleet playing an active or expectant part as the attacking forces utilize their capital ships as corsairs.

THE present growth in battleship ton-nage, as shown in this present review of 35,000 tonners being built by the Powers, is due to Japan's having withdrawn from the Naval Conference two year- ago When she intimated her unwilliagness to continue the exchange of naval information or to adhere to the limitations in displacement butherto observed by the Powers, it was generally anticipated that her intention would be to enlarge her battlefleet by the construction of ships of more than 35,000 tons-which was the agreed limit-and with her predilection for the heaviest guns, everything pointed to an increase in their carrying weapons of more than 14-inch caliber In due course, it was reported that three or four 40,000 tonners carrying 16-inch guns had been laid down, and as neither confirmation nor denial of this was vouchsafed by the Japanese authorities, there was no other course open for the United States and British Governments but to conclude that this information was probably correct and to increase the dimensions and armament of their new ships accordingly.

On the other hand, it must be reinembered that the Treaty also provided that no warship other than a capital ship should carry a gun of greater caliber than 8 inches-whileh precluded the construction of a variety of intermediate types such as the German Deutschland and light battle-cruisers. This wase provision simplified design and climnated the risk of existing types being compronised by hybrids. But today the sanctity of Treaty designs no longer obtamlapan may have no intention of embarking upon a vastly expensive big-ship program. Her secrecy may be an excellent cover for what might prove a far more troublesome Treaty escape-the construction of "intermediate" ships. In the past, she has complicated the accepted categories by such ships as the 12-inch gun, armored cruisers Tsukuba and the larger Kurama of 1905; and after the War when introducing the 8-inch gun in the Kako class (1922) she initiated the Washington eruisers-which were neith er wanted nor welcomed! Today, it is quite in the eards that the 40,000 tonners are a blind and that fast, 12-inch-gunned ships of moderate tonnage arc being built, If so, our troubles in Eastern waters will be considerably increased as such ships would be able to smash up the standard 8-meh gun erussers and escape from any of the 21-knot battleships which are at present available and which cannot be reinforced by faster capital ships for some years to come.

The American answer to the Japanese challenge is a class of six 35,000-ton ships of the North Carolina class now being built under the 1937-38 programs. They carry an armament of nine 16 inch and 20 5 inch guns, with two triple turrets forward and one aft, with the secondary guns-of which eight are reported to be 5-meh. 25-caliber anti-aircraft-grouped in small turrets amidships. To a large extent they represent the conventional layout observed by all the Powers except France, Formerly, it was customary to break the hull line by a deck at the after superstructure and space the sec ondary battery along the upper deck side or along the superstructure deck in casemates. Nowadays the demands for high angle fire and wide arcs of training have led to the adoption of small turrets on two levels to avoid interference. In the North Carolinas, four of these are on the weather deck and six on the superstructure, with multiple anti-aircraft positions high up on the fore and aft shelter decks. At the stern are two catapults with a hull hangar as in the Brooklyn cruisers -an admirable arrangement if practice bears out theory.

In these days when so much information is confidential, only a general idea of armot thickness is available. This indicates that the waterline belt is of 16-inch armor antichips from the fore to the after turrets, with a six-inch upper deck and a four-inch lower deck-these being very heavy to withstand plunging fire from big guiss and heavy bomb



Italy's "Littorio" and "Vittorio Veneto," to be ready this summer the first of the 35,000 tonners being built by the Powers. For a time they will be most formidable ships affoat



HMS "King George V," of a class of five now building. Note secondary guns paired in shields allower funnels

The designed speed is reported to be about 28 knots, in which case the class will be about two knots slower than the Brush, French, and German 35,000 and rence. However, as they carry 16-inch against 15-inch or 14-inch guins and are specifically designed to meet the Japanese battleships of alleged greater ton-nage with 16-inch weapons, the sacrification of speed as that which can best be afford of a proposition of a proposition of the sacrification of the sacrificati

As the cage mast gave way to the tripod, and that, in its turn, has been superseded by the bridge-and-tower structure of the Idaho class, so in the North Carohna a new type has been evolved; a truncated cone supporting the heavy range-finder which resembles the "mast favored by the Germans Aft, there is a light pole only-the remnant of a main mast which is now just a huidrance to sky-fire. A glance at the layout of previous battleships will show to what an extent their after tripods or eages mask the anti-arcraft guns on any off-side ceiling, and the present tendency is to afford as wide and as uninterrupted a field as possible to anti-aircraft defense

In Britain, two classes of battleship are now in hand: the King George I', and the Lion The former, designed in accordance with Treaty limits, is of 35,000 tons and armed with 14-inch guns. No dimensions have as yet been published, but the length is about 750 feet as in the United States' ships; and the main armament of ten guns is carried in three turrets; a quadruple and a twin superfiring forward and a quadruple aft. This is a complete breakaway from the Nelson layont with its three turrets up forward, and allows for a good all-round concentration of fire. Instead of the customary 6-inch gun for secondary armanient, a new gun of 5.2-inch has been adopted. Sixteen of these are carried in four groups of twin turrets, the inner guns being raised on small separate superstructures. Multiple om-poms are mounted on the crowns of B and C turrets and on platforms abreast of the fure furned, which allows for work arts of sky fire. Other anti-arcraft guns are disposed on the superstructures. On deck letween the funnels is laid a frour subject early with hangars for our arcraft on each side of the fore finnel, the cranes for handling both aureaft and boats being stepped on the after superstructure. Between the end nurets, there is a belt of 16 inch atmost, tapering to 15 met, reaching up to the main deck, and over 11,000 tons of armor have been distributed over the sides and decks. Unofinal reports credit a speed of 30 knots with 130,000 bors power.

This class will be retained in European waters when they are commissioned in 1910 and 1911,

I N then four vessels of the Rucheleu class, the French have retained the characteristics of the previous Dankerque (26,500 tons, eight 15-inch guns), enlarging the hill to the 35,000 ton limit in order to carry eight 15-inch guns These are in two woldy separated turrets forward, in each of which are two pairs of guns sensitical by an atmo bulkhead

a disposition primiting a heavy concentration of fix forward and just abait the beam but powerless to engage an enmy on the quarter or astern Although this is admirable as an offensive distribution of turrets, experience during maneusers with the British Nelson and Rodary has demonstrated its dangers, and in a running fight with the enemy astern these shape were unable to return

The 13.6 mch gans which will form them secondary animanent are in hie triph intrits, two on each side and one on the centroline over the hangar aft Between these are two 3.9-inch antiaircaff gans and a larger number of smaller sky gans are distributed over the superstructure. Four planes are stowed in the hangar which extends onto the quarter deek, with two catapulis.

Nothing so imposing as the bridgetower has ever been erected on any warship. As now contemplated, it will be a huge, almost triangular, structure with the blanted apex forward carrying a crown of range-index. In the British King George V, the tower contains the coming tower; in the French Richelien, this is seen rising through at two-decked bridge at its forward base. In the drawing, note the searchlights on control towers alreast the funnel and the curious pagoda of controls, aft, from which arises the main many

The total weight of armor is just over 15,000 tons, the heaviest proportion to displacement yet assigned to any capital slup so far as 15 known From the forward turret to the after 6-nich triple, the belt is 16-inch with 9-inch continnations to bow and stern, turrets are 16 inch face and 14-inch side armor, and the upper and lower armor decks total 8 inches-a truly wonderful carapace against vertical attack! With but six high-pressure boilers, the horsepower is 155.000, giving a speed of 30 knots and more, the funnel so close to the tower is likely to prove troublesome in a fol-lowing wind. The Richelieu will be ready in 1939, the Jean Bart in 1940, and (lemenceau and Gascogne in 1941.

The present rapid increase in the German Navy is now of especial interest in America as the Chancellor aims at regaining the former colonies of the Reich which would allow for the development of naval bases on the west coast of Africa within striking distance of the American continent In the event of a successful campaign in Europe, this aim might be achieved, in which case an alliance with Japan would consolidate the German plans to extend her interests in South America. For the present, there is an agreement by which the Reich limits the coustruction of surface vessels to 35 percent of the British Navy with an elastic interpretation as applied to the submatine atm. But Germany has learned by experience that in a short war she would not need to have command of the sea so far as surface ships were concerned; a big and efficient submarine fleet would play more havoc with the British Empire than a ratio of more than 35 percent of battleships and cruisers. And present-day German strategy does not aim at keeping a great fleet standing by



The German 35,000 tomers, now building, have immense beam and massive protection. Absence of main most permits anti-aircraft cross-fire

> France's "Richelieu" has two quadruple turrers of 15-inch guns. Note great conning tower surrounded by bridgework, and huge tower mast

in North Sea harbors for coast defense purposes. Her new capital ships are to be sent out in company with carriers and cruisers to prey upon shipping, and the main problem of the Bitish battle fleet will be to try to prevent such forces from shipping through the northern exits from the North Sea in fog and darkness.

For this reason she has given her Scharnhorst and Gneischau, just completed, a speed of 27 knots, and aims at 30 knots or more in the 35,000 tonners now building. Both Germany and Italy are responsible for introducing high speed into battleships, thereby greatly increasing their size—as speed demands length unless power is to be increased out of all proportion to displacementtheir cost, and their individual asset value. The first of these 35,000 tonners, the Bismarck, was launched about four months ago and the second, the Admiral von Tirpitz, on April 1; the third was laid down last year; and a fourth is projected and likely to be commenced during 1939. They will be 792 feet long -40 feet longer than the American and British designs-with the colossal beam of 118 feet and only 26 feet mean draft to allow for shallow North Sea work. Such a beam means immense docks but will permit of under-water subdivision never before attempted, which should give near-immunity to torpedo attack.

Under the Versailles Treaty, the higgest gan permitted in the Cenuan Neywas 11 inches on a displacement limited to 10,000 tons. These restrictions princed the famous Deatschland class, able to outsteam all battleships and outgan all cruisers. In the two Schardnorts, just completed, displacement was raised to 25,500 tons to privide adequate protection for a hull carrying nine 11-inch guns as a main armament Hence they will be able to work in concert with the Deatschlands and utilize the guns already built.

In the new \$5,000 tonners there was no question of following the British example with 14-inch guns, and in a single step the Marine Arm decided to go me better than the King George V class now building. There will be two turrels fore and aft carrying 15-inch guns with 12 6-inch guns amidships in four twin- and four single gun positions. Fourteen 4.1-inch anti-aircraft guns are to be spaced a deck higher, six saids amidships and a



pair aft firing over the third turret. This arrangement makes for an undue concentration of small guns around the base of the funnel, where they are extremely vulnerable; it is possible that the catapult will be moved to the quarter deck to allow for more generous spacing of the smaller guns.

The General case a moderate freeboard with a marked theer towards the bows, and are "analtet arget" ships. Gearet utraines, in combanation with Diesels and very high pressure botters, allow for a single funnel with a broad trunk basearound which is built a searchlight plattorm serving as a support to a light tripod pole must for the radio aerials. By keeping the rig forward of anudshups, the ann aircraft guns have unobstructed ares of sky bearing, which is really only evident upon observation from the decks of the Scharhorst or Leeping.

No details as to protection are available, but it may be taken for granted that the armor allowance will be as generous as in their contemporaries and fully utilized to the last ton and maximum advantage.

After considerable delays, Italy's first modern battleships, the Listorio and Varioto Veneto, will be ready for sea this summer and their trials will be watched with considerable interest as their engines are designed for 160,000 horse-power—the highest ever installed in warshaps barring the U.S.S. Saratoga and U.S.S. Lexargon. This power is intended to realize 32 knots, and Parsons grared turbines have been installed instead of the Belluzzo type fitted in battleships recently reconstructed. Such a speed makes the category of "battle cruiser" superfluous, and is in keeping with the very

high rates of steaming recorded by postwar Italian cruisers and destroyers.

The four ships of the Littorio class are 774 feet long with a beam of 103 feet and a mean draft of 28 feet, giving the standard displacement of 35,000 tous common to all the battleships under review. The three turrets house triple 15 inch guns, and at the four corners of the superstructure are smaller triple 6-inch turrets, with three pairs of 3.5-inch, anti-aircraft guns between them. Twenty smaller sky guns are carried and may be seen nested on the turret crowns and hangars. With such an armament and speed, there has had to be some sacrifice in protection so that the main belt is reduced to 9 to 12-inch, and the turret and deck armor should be proportional to this.

The foremast is a cone crowned by the big range-finder and surrounded by bridgework, with an unusually heavy tripod aft currying searchlights and antiuircraft guns; abreast the fore funnel are the hangars, with catapults along the edge of the boat deck amidships. Italian constructors now favor two funnels when possible, as a bad lut on a single stack would seriously affect furnace draught and these two ships, with the Roma and Impero now on the stocks, will have the same general profile as the four reconstructed Cavours, the funnels being of unequal height with cutaway black caps which are said to assist in keeping the fire control clear of smoke in a following wind.

Presumably intended for hit-and-run operations, the four ships of the Littorio class will present a very serious problem in the Mediterranean although it is anticipated that Italy will depend upon small craft rather than expose her battleships to the risks of a fleet action.

How METALS RELAX

Research Engineers Demonstrate that Metals Stretch and Lose Their Grip with Time and High Temperature

S TEEL bolts and rivets creep and relax, research engineers have reported at the conclusion of a three-year investigation at the Westinghouse Research Laboratories.

The nuestigators have invented an automatic relaxation machine which determines within a few hours how much intends will relax in many years. Engineers A. Nada and John Bod have been heating, stretching, and "relaxing" copper and steet to discover how and why bolts eventually lose their grip inder high temperatures.

mgs temperatures.
This habit of metals to relax has long been a problem in great steam tubins where heat is converted into power to run the machines of the modern world. The problem comes closer home to the average person when the garage mus finds that the bolts in the motor head of his automobile are loose. The unseen cause of the loosempt is sterey and relaxation resulting from the heat of the automobile engine—two phenomens characteristic of all metals, particularly at elevated temperatures.

"So far as we know, there exists no metal which does not display this deformation characteristic," observed Dr Nadai. "If sufficient time is allowed, all metals and any other solids will creep or deform under continuous loads, even at low room temperatures."

When an engineer designs a steel bridge, he can calculate the stress and strength of the steel and know how his bridge will be able to carry a definite tool 100 years from now. But when an engineer designs a steam turbine, he must take the effects of heat into consideration because the temperature will determine the effective life of his machine. Temperatures have steadily climbed upward in modern atsem turbine applications until today the steam pipes of a turbine in a modern central power station start to glow at heats of more than 1000 degrees, Fahrenhelt.

But if the steel used does not creep more than one one-hundred-millionths of an inch during every hour of the life of the steam turbine, the engineer is satisfied that is life expectancy will meet present practical requirements. This "permissible" amount of creep figures out to be one one-thousandth of an inch over a period of ten years. When a bolt is uplaned into place, it is actually stretched in the tightening process since a stress sometimes as high as 60,000 pounds to the square inch is applied. While held in this position the bolt is not permitted to contract but its stress gradually decreases; that is, the bolt retaxes its bold in time.

Consider a spring as another illustration. When it is stretched out and released, it springs back to its normal position. But if the same spring is stretched and then

heated at a high temperature, it will notpring all the way back to its original position It has been permanently deformed and its elastic strain has been gradually transformed into a permanent plastic strain or deformation.

The investigators used copper bars in attempts to discover the severets of relaxation. They selected copper for the first tests because of its importance in electrical machinery and its purity as a metal. They loaded the test pieces with weights, maintained the temperature in the room at 77 degrees, Fahrenheit, and charted the amount of stretch.

NEXT, identical test hars were placed in a relaxation machine where, this time, the load was automatically light-end to maintain the bar at a constant length. It was ducovered that the results of the creep test and the relaxation test could be closely correlated. Thus it is possible to predict the rapidary of coper's relaxation at room temperature studying the creep, or vice versus.

Af room temperature, copper will hold its own for a good many years without appreciably losing lis grip. On the basis of these tests, the investigators calculated that a copper har starting with a stress of 19,850 pounds to the square inch would relax only to 12,600 pounds of stress in a 20-year period, provided the temperature did not exceed 77 degrees.

But at a temperature of 350 degrees, Fahrenheit, copper would relax from 19,200 pounds stress to 2000 pounds dur-



Examination and adjustment of electrical contacts of the unique automatic relaxation machine

ing this same period. The relaxation was so rapid that the test bar would be inloaded perhaps after a few initutes if the temperature were shot up to 500 degrees,

Fahrenheit.
Even steel, much harder than copper, would relax 60 percent from an initial stress of 11,750 pounds if maintained at a temperature of 850 degrees for 20

years, the tests disclosed.

Several additional experiments showed that by frequently relightening a steel bolt when it became loose, it was possible to strengthen it and increase its resist-

ance to relaxation. These discoveries have convinced Dr. Nadai that "our engineers must find the new laws" underlying the phenomena of creep and relaxation, "If the engineers are to continue their steady advance in making steam turbines ever more efficient power producers." He pointed out that "the theory of clasticity is the base of all engineering design now taught in the schools, but no adequate theory of creep yet exists."

Both men expressed confidence that the invention of the automatic relaxation machine is a step toward creation of such a theory. The apparatus is so designed that a metal test sample is weighted by a spring which is stretched by a worm drive connected to a motor. While an electric furnace heats the test piece, sensitive electric contacts operate the motor to adjust the load and maintain the sample at a constant length despite the stretching of the metal.

he first step in the process is the pouring of

Controlling

THE method by which astronomers discovered helium on the sun before it was known to exist on the earth also iron and steel in the Ford Moto Company's foundry. The method is spectrographic analysis, and it enables the metallungists to know that each 'heat' of the metal is right before its pound of

The new analytic method has been in operation long enough to show that it is both faster and more accurate than the chemical method it supplements. It quickly shows the important elements in each heat and the proportions of each. This permits closer control over the molten foundry aron and steel, and means that uniform quality is constantly maintained.

Asked to explain the basis of the method, one of the metallurgists pointed out that salt thrown on a flane causes it, because of the sodium it contains, to burn with a yellow color,

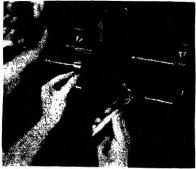
"When burning, each of the other clements has a characteristic color, although many of these colors are invisible to the human eye." Be said, "To be also to see the colors—and in that way identity the metals in an alloy—we burn the alloy in a spark-gap and, with a prism, break up the light it gives off into a rambow,' or series of spectral lines. We photograph this pattern of lines By studying the photograph we learn what metals are present in the allos, By measuring the density of the lines by a very deleate microphotometer we can tell the proportion of each element."

For routine analysis in the Ford foundry, a foundryman pours a special buttle casting which is sped about 1600 feet to the spectrographic laboratory an a pneumatic tube like those used in department stores to transfer change A laboratory assistant grands one end to make it bright, and in-erts the sample in the 40,000 volt spark gap



The tiny casting is quickly cooled and removed from the mold, and a complete record then made of it





After one end of the sample has been ground in the laboratory, it is placed in a 40,000-volt spark gap, has its spectrum snapshotted

THE HEAT

Complete Analysis of Industrial Iron, Steel by Spectrographs . . . Made During the "Heat" in Few Minutes . . . Necessary Alloying Elements Then Added

Light from the spark-gap goes into the -pectrograph, where the prism breaks it up into the spectra mentioned above. The photograph is quickly developed and then analyzed in the microphotometer, which was especially developed, by an application of the "electric eye" prin-ciple, for the work. Within 10 minutes, or even less, from the time the sample is poured, the report has been sent back through the pneumatic tube to the foundry foreman, He then orders silicon, thronium, copper, molybdenum, manganese, or niekel added in just the quantities needed to bring that heat precisely up to specifications. Then it is poured

IN addition to close control of quality, the spectrographic method opens up new avenues for research into the characteristics of metals. It also gives the metallurgists a swift method for identifying unknown elements in a nuxture and performing similar jobs which are often extremely tedious by chemical methods of analysis.

As done in the Ford spectrographic laboratory, nine samples may be analyzed simultaneously for six different clements, a total of 54 quantitative determinations, all in a few minutes. The great value of this speed, in a foundry that pours several hundred tons of cast iron and cast alloy steel a day, is obvious.

Practical application of the spectrographic method to routine control of foundry output was the work of Messrs. H B. Vincent and R. A. Sawyer of the department of engineering research of the University of Michigan, Its first foundry application was in the Campbell, Wyant & Cannon Foundry at Muskegon, Michigan; and experience gained in the operation there, dictated the changes and improvements incorporated in the Ford spectrographic laboratory It is the world's most advanced laboratory

Of particular interest to photographic fans is the method used for drying the plates on which the spectral lines are photographed. Time for processing the mum if the speed of the method is not to be largely lost in the dark room. A high contrast, fine-grain plate is used. After a quick trip through the developing and fixing tanks it is rinsed in distilled water, making sure no ininerals which might affect the density of the spectral lines remain. It then is dried in about 30 seconds in a special "toaster" consisting of an electric heating element and a blower, and sent to the microphotonieter for analysis



a report sent to the foundry to guide the fore



The spectrographic plate is then examined in a microphotometer



Light from the spark is sent into a spectrograph which contains a photographic plate





Taken especially for Scientific American by Betty Menzies Professor Einstein at home in his study

(Part One) The Special Theory

TWENTY years ago, the world, emerging from that cataclysm in whose dark shadow it is even yet engulfed, was electrified by the predictions of a scientific theory of unparalleled boldness, the general relativity theory of Albert Einstein, Hailed as a revolutionary theory, in a field in which heterodoxy then seemed to entail no objectionable sociological implications, it constituted for many a pleasant escape from the war's sordid aftermath of recrimination and disillusionment. Public interest in relativity and its spectacular astronomical consequences was heightened by the journalistic fable that there was, according to its author, but a handful of spccialists capable of understanding the theory-a fable branded by Einstein himself as one "invented as a consolation for those too lazy to think!" A hundred books and a thousand articles-a good majority designed for the consumption of "the man in the street"-were written before public interest wancd in favor of Tutenkhamon and things Egyptian, a fad more easily adaptable to the fashions of accoutrement and coiffure.

But those who followed more closely the development of the general theory of relativity knew that behind it lay Einstein's 1905, or special, theory—the historical, if not the logical, background of the more spectacular theory of gravitation. In many ways of grater importance for the general body of physical knowl-dege, the special theory was the logical

Relativity_

outcome of decades of con flict between the classical mechanics and the growing body of optics and electromagnetic theory. Strange as it seemed at first with its surrender of the concept of absolute simultaneity, it underwent a steady development and clarification in the decade following its inception. The striking paradoxes to which it gave rise. most illuminatingly resolved during this period by the revolutionary space-time geometry associated with the name of its distinguished cxponent Minkowski, sccm to have attracted but little attention outside the circle of scientists who concerned themselves with fields directly affected by the theory.

was firmly established on the solid base of experimental findings, and, although logically independent of the general theory, it was thoroughly incorporated as a special case into the latter more embracing destruct. It, too, then came into its share of general interest, especially in view of its renunciation of the absolute time so universally employed by its predecessors, and the paradoxes—such as that of the traveling twins—to which this renunciation of this remunciation gave rise.

What, then, has been the fate of these two theories during the past two decades-the special theory itself, and the more inclusive theory of gravitation? What of the speculative theory of the "expanding universe," which has been grafted onto the general theory during this time? And what credence is to be given the vitriolic attacks launched recently on the theory and its author by those fanatics who would reform physical science along the lines laid down by political or racial dogma? To answer these questions and, more, to follow the unfolding of these theories during the past 20 years, is the purpose of this article. Let us begin with a review of developments in the special theory, as the question of its validity is quite independent of the validity of the later general theory-although the converse of this statement is not true.

First, we consider the status of the historical Michelson-Morley experiment, which has undoubtedly served, more than any other single experiment, to initiate that train of thought which was to cul-

minate in the special theory of relativity. As pointed out by Maxwell in 1878, if light is propagated through a stationary ether with a constant velocity, then the motion of an observing apparatus through this medium should give rise to optical effects which would, in principle at least, enable the observer to determine his velocity with respect to the etherlight should under these circumstances take longer to travel a given distance travel the same distance across and back. a discrepancy which should be observable with the aid of a suitably designed apparatus for the detection of interference between the two re-united beams. And, since the Earth is traveling around the sun with a speed of 30 kilometers per second, in the most unfavorable case its maximum velocity relative to the hypostacized other must be at least this large-unless the ether is substantially entrained by the matter composing the Earth, in which case there would be great difficulty in explaining the well-known phenomenon of aberration of light from the stars. In spite of the minuteness of this "second order" effect—depending only on the square (v/c)2 of the ratio of the velocity v of the observer to the velocity c of light-its detection seemed well within the range of observational technique. Experiments on this effect at the Case School of Applied Science in Cleveland, carried out by Michelson and Morley in 1887 and by Morley and Miller around 1905, failed to reveal this predicted effect; their results were, at the beginning of the period covered in this report, generally taken as a confirmation of the theory of relativity, according to which there should be a null-effect. But in 1925 D. C. Miller announced that a careful repetition of the experiment on Mt. Wilson showed, not the predicted re-sult, but one which he could explain only by assuming that the solar system was moving some 200 kilometers per second through the light-bearing medium, and that this medium was entrained by the Earth to such an extent that the relative velocity in the interferometer house on Mt. Wilson was reduced to a mere 10 kilometers per second. As such an effect would be extremely difficult to explain by a modification of the classical theory. and presumably impossible on the relativity theory, the question of its existence became of great importance.

ATER experiments by Kennedy and Michelson on Mt. Wilson and Joos in Jena failed to show the effect, although

20 Years After

An Evaluation of the Achievements of the Special and General Theories of Relativity During the 20 Years which Have Elapsed since the First Direct Observational Test of the General Theory

> By H. P. ROBERTSON. Ph.D. Professor of Mathematical Physics, Princeton University

the apparatus employed by the former and the latter should have been capable of detecting a relative velocity of as little as one kilometer per second! Miller's suggestion that this null-effect might be explained by assuming that the more substantial housings in which these experiments were performed might be responsible for a further entrainment of the ether, seems untenable in view of the most simple and ingenious experiment performed by Hammar of Idaho in 1934. Hammar reasoned that such an explanation would lead to an easily detectable "first-order effect" (depending on the ratio v/c itself) if one arm of the interferometer were encased in a heavy tube; with such an apparatus, capable of showing a differential entrainment of one kilometer per second, no such effect was observed. That the highly mystifying effects predicted by the Englishman Hicks, Cartmel of Montreal and others, due to imperfect alinement of the apparatus. are in fact spurious was shown by the more complete analysis published by Kennedy in 1935. The bulk of the evidence is thus directly in favor of the null-effect, and hence indirectly in favor of the relativity theory, although a completely satisfactory explanation of the outstanding exception, the Miller experiments, has not to date been given. One interesting possibility which has been suggested is that Miller did not adequately allow for magnetostriction, due to the action of the Earth's magnetic field on the interferometer base, but to my knowledge no independent analysis of the data, with this feature in mind, has been carried through.

A DIRECT confirmation of the valid-ity of the second order term in the relativistic expression for the Doppler effect was announced last spring by H. E. Ives of the Bell Laboratories. By an ingenious arrangement of mirrors Ives was able to observe the Doppler shift in an oncoming hydrogen beam, and at the same time the shift due to the recession of the same beam; on comparing the center of gravity of these two shifted beams with the undisplaced line, the predicted term was verified, although the displacement was just about at the limit of the resolving power of the optical system,

Surprisingly enough, the keen analysis earlier last year by Zahn and Spees, of Ann Arbor, of the fundamental experiments of the German physicists Bucherer and Neumann, long accepted as establishing the relativistic variation of mass with velocity, shows that they actually prove little more than an increase of mass, as the resolution in these older experiments is too poor to give quantitative results, Because of the general belief in the validity of these original experiments, little, if any, advance in this direction has been made since their performance-with the result, as emphasized by Zahii and Spees, that "in view of the fundamental importance of such experiments it seems that much is left to be desired." It is to be hoped that this challenge will soon be met, and that, with the aid of modern technique, we shall obtain a surer knowledge of this effect

for particles of high velocity.

Another result skirted upon by electromagnetic theory, and more definitively expressed by relativity, is the equivalence of mass and energy. This effect, which has long been speculated upon as a possible-perhaps the only possiblesource of stellar energy, has been employed as one of the most important theoretical tools in the recent developments in nuclear physics. The consistency of the modern table of atomic weights, usually given to four places after the decimal point, under nuclear transformations may be regarded as a most valuable in-direct confirmation of this equivalence. This growing body of knowledge gives great promise of yielding an evolutionary interpretation of the main features of the Russell diagram relating the luminosity of a star to its typepromise the fulfillment of which has been materially furthered by the recent work of Bethe of Cornell, and of Gamow and Teller of George WashPROFESSOR Einstein pub-I lished his special theory of relativity in 1905, but the public did not discover it. He published his general theory of relativity in 1915, but the world was precupied with its Futile Quarrel and again failed to give notice. An eclipse of the Sun that took place on May 29, 1919, first focused press and public's thoughts strongly on relativity, because this afforded the first actual observational check on the general theory. This present month, 20 years after that pivotal date, is chosen to offer our readers an estimate of the present status of relativity. The author has specialized in mathematical physics. —The Editor

ington. Thus the former would consider the stars of the "main sequence" as fed by the energy liberated on the combination of protons and electrons into an α-particle, the by product of a lengthy chain of nuclear reactions involving carbon and nitrogen.

Finally, the greatest single triumph of the special theory during the past 20 years is its immense importance for the theory of atomic structure. At the beginning of this period it was employed, with great success, by Sommerfeld of Munich to explain the observed fine structure of the hydrogen spectrum. This was followed by the seven lean years prior to the development of modern quantum mechanics, in which the attempt to explain the structure of other spectra was frustrated in large part by the fact that the alkali doublets, whose separation was of the same order of magnitude as this relativistic effect, could for other compelling reasons not be so interpreted. The resolution of this dilemma by the semi-empirical introduction of the electron spin, by the Dutch physicists Uhlenbeck and Goudsmit, and the derivation by Dirac of Cambridge of the spin from accepted principles of quantum and relativity theories alone, constitutes one of the greatest chapters in atomic theory.

I N view of these developments one may say that at present the special theory of relativity is one of the most thoroughly accepted and most firmly established doctrines of modern physics. It has permeated the fields of mechanics, electromagnetism (including optics) and atomic physics; while it may appear desirable to have further direct checks on the validity of its mechanical aspects, a deviation from the predicted effects would constitute a most puzzling-and, at least temporarily, distressing-jolt for modern physics.

(Part Two-The General Theory-will appear in July)

Railroading's Latest Chapter



One of the two identical units of the new Union Pacific Steam-electric locomotive. Units may be operated separately or together. Note the engineer's high perch

STEAM is riding the rails in a new

whele, as it has done in receipt driving the whele, as it has done in reciprotating steam becometives for the past century, steam has been harnessed to function at increased temperature and pressure through small but manzingly powerful turbines installed in a locomotive And the turbine—stalled in modern power plants through-installed in modern power plants throughout the country—installed mandern power plants through-installed in modern power plants through-installed installed in the properties of t

This is the radically new steam-electric locomotive built by the General Flectric Company for Union Pacific's fast massenger service between Chicago and the Pacific coast. It can haul a 12-ear passenger train over the 2.2 percent grades encountered on that run and will operate safely at speeds up to 125 miles per hour It will do twice the work of the conventional steam locomotive for the same amount of fuel. The first locomotive of its kind in the world, the steam electric locomotive introduces another type of motive power to rail transportation, and opens a new chapter in the romancestudded history of American railroading.

lust ten years more than a century ago-Horatto Alleu, who had been at the throttle of the Stoutbridge Lon on its first trial run in this country, summed up a report to the South Carolina Railroad on the respective economies of stem locomotives and horses with the following words: "There is no reason to expect any maternal improvement in the breed of horses, while in my judgment, the man is not living who knows what the breed of

the loconotive is to place at command."

The 'breed" of the loconotive has certainly lived up to and far outdistanced the possibilities foreseen for it by Allen And his comment is still true of any type locomotive in service today

STEAM transportation, introduced to this country by the imported English Stanibudge Lian in 1829, still provide the mainstay of motive power for the American indiracids Of the 485,000 Incontotives now in service in our country, all but a small percentage of them are of the reciprocating steam type Since the De Witz Clauton hauled its first tain on August 9, 1831 over the 17 nules between Albany and Schenetaday in the time of one hour and 45 munites, continuous development and improvement of the steam to-concutive has been taking of the steam becometive has been taking

place.

It was not until 1895 that a new type of motive power appeared on the seene to challenge the reign of steam in rail transportation. In that year the Baltimore and Ohio began operating the first standard railway elevetre tunk line. At the time there were many who predicted the electric locomotive would soon replace the then well-established steam locomotive. But it soon became apparent that the electric locomotive could be used economically only where there was

sufficiently heavy main line traffic to justify the expense of creeting and maintaining a costly overhead power system.

Steam's latest important competition came along in 1934 in the form of the Diesel-electric becomotive and Diesel relaid and Quincy Railroad part is lightweight, articulated Zephyr into service between Kansas City, Omaha, and Lincoln. In a bort time, the Diesel-electric becomotive became synonymous with speed and modernity in rail transportation. The slevk.



Interior of the cab showing simplicity of controls and operator's chair

richly appointed Pullmans and passenger coaches which were flashed across the country by Dissel-electric locomores quackly capaired the imagination of the American public Ar conditioning, introduced at about the same time of the company of the time-looped tool horse! So real was it, in add, that numeriate steps were taken to maintain the prestige of the steam horsentor.

In 1935, two streamlined steam locentives were produced to pull the "Hia-watha" trains between Chicago and Minneapolis at greatly increased speeds. Now streamlining has been the fashion in steam as well as Direchelectric locomotives, and of the 43 streamlined becomitives produced in 1938, 25 were steam, 18 were Disechelectric.

The biggest advantage of the Diesel is its high availability. It can be maintained in continuous service for longer periods than the steam locomotive without stops for rest and overhauling and

Steam and Electricity Co-Starred . . . New Locomotive Has Advantages Over Present Motive Power . . . Thermal Efficiency High . . . Unique Features

By C. P. FISHER, Ic.

can travel greater distances without stop omg for fuel or water. The cost of Diesel operation will not exceed two thirds of that for an equivalent steamer

But initial cost still favors the steam locomotive. It costs only one quarter to a third the delivery price of a Diesel electric of equal power and speed. The Diesel, however, has greater tractive cffort at low speeds. For that reason it has become extremely popular in switching service on rathoads and in industrial plants.

No comparison is available as yet on the operating of maintenance costs of the new steam-electro and Diesel-electric types of locomotives, but it is expected that those of the former will be lower The strani-electric locomotive has its fuel

One of the two main drive turbine and gear mus being assembled

fed into a big box rather than into a combustion engine and for that reason can burn a very low-cost petroleum, known as 'bunker C" oil

In essence, the steam-electric locomotive combines the inherent advantages of both the reciprocating steam becomotive and the straight electric locomotive, plus the rehability, efficiency, and compactness of the steam turbine, a prime mover proved beyond a doubt in thousands of central stations. The steam turbine has no reciprocating parts, no Inbrication difhealties, and when properly applied is most efficient in the use of fuel It is this combination of the proved advantages of the steam becomotive, the electrical locamotive, and the steam turbine which makes the steam-electric locomotive most mteresting

DISCUSSIONS of plans for building the stram) lectric locomotive were taking place even before the Diesel-electin locomotive loomed as a factor in the transportation industry. Space limitations presented one of the principal problems in binlding the steam electric locomotive A steam timbule for a power plant might sprawl out to any reasonable proportions, but there were definite limitations in building one to generate power in a locomptive. Locomotives' dimensions are restricted because of clearance requirements of bridges and tunnels I ength cannot exceed that point at which flexibility for rounding curves is lost

The Union Pacific steam electric becomotive consists of two identical units,



View inside the cub nose showing some of the train control equipment

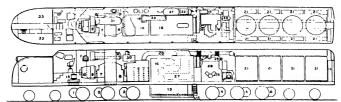
each 90 feet 10 inches long, weighing 530,000 pounds, and rated 2500 horsepower Each is complete in itself and may be operated individually as an independent becomotive, or the two may be operated in multiple under the control of a single operator. As an incidental point of interest, this is the first time in the world that two steam powered locomotives have been operated in multiple

The sides and roof of each unit are of sheet aluminum, eliminating unnecessary weight, although the moses of the cabs are of ordinary carbon steel. The cab-frames are built of high-strength steel tuhulai members

Each motive power unn not only supplies the rated 2500 horsepower for traction purposes, but also supplies the power for auxiliary electric power through out the train, as well as the steam for heating the trailing coaches,

The main turbine set of each cab is self-contained with high- and low-pressure units mounted on a common base

(Please turn to page 388)



Compact arrangement of the equipment in the new steamelectric locomotive. By the numbers: I to 6, traction motors; 7-8, main generators; 9, alternators; 10, exciter; 11, battery charging set; 13, main control contactors; 14, battery; 16. boiler; 18, high-pressure main turbine; 19, low-pressure main

turbine; 20, exhaust header, 21, an-cooled condensers; 23, high level condensate tank, 28, hoiler auxiliary set turhine; 30, compressor; 31, train heating evaporator; 33, raw water tank. This concentration of equipment, unique in its conception, had to be carried out under rigid dimensional limitations

Sulfanilamide and Sulfapyridine

GREAT discoveries in chemotherapy are rare. For all the prodigious efforts spent in the attempt to discover drugs having marked action in germ diseases, today there are only a few great specifics, such as quinine for malaria and the arsenical for syphilis.

We must then regard recent progress in the development of powerful chemotherapeutic agents as the opening of a new era. Within less than four years, two chemical agents of outstanding value to medicine have been introduced.

One, sulfaniamide, has gamed established application in treating, often curing, a number of acute infections caused by particular strains of bacteria—the so-called beta hemolytic streptococci of eryspleas, childbirth infections, blood infections (septicemia), septic servicionis, selectrorat, meningitis, And it has revolutionized the treatment of gonorrhea. It may or may not turn out to be beneficial in certain types of pneumonia, though conservative investuetors are doubtful.

The other, sulfapyridane, a derivative of sulfanilimate already appears to rival, if not surpass, sulfaniliamide's established values. Moreover, in severe infections caused by that most common possproducing organism, the golden-yellow staphylococcus, sulfapyridane has migue effectiveness. In preumonia, despite press and radio publicity, sulfa pyrdine's future is unknown, though promising at present. English clinicians are far more optimistic. Yet the new rabbit and horse serums must remain the most effective pneumonia treatment.

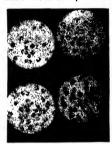
WHETHER or not pneumonia therapy is advanced through these new drugs, both of them are specifics of rare importance. The discovery of sulfapyridine so soon after the introduction of sulfamilamide indicates that in this group of chemical compounds we have molecules exhibiting priceless physiological activity. Where one derivative of sulfanilamide is so potent, there must be other derivatives as powerful in their therapeutic action, not only against the bacteria already brought largely under control but against other germs. Study of sulfanilamide and its kin molecules brought sulfapyridine. Further studies will probably give man additional weapons against his subtlest enemies.

The existence of the sulfanilamide (para-amino-benzene-sulfonamide) molecule was discovered in 1908, by dye chemista. In 1913, the possibility of using such dye molecules in chemotherapy was suggested, and a number of these sub-

Now that Enough Time has Elapsed to Permit Calm Estimate of These Newly Developed Drugs, How and Where do They Stand in the World of Medicine?

By BARCLAY MOON NEWMAN

stances were subsequently found to have limited value as anti-bacterial agents. In 1935, German scientists, guided by G. Domagk, determined that prontosil, which contains the sulfanilamide structure, is effective in streptococcus infections in mice. The use of prontosil was



Some of the bacteria against which the new drugs make successful war. The bacteria are the tiny dots

promptly extended to man, in clinics throughout the world. Finally, the most active fragment of prontosil was shown to be para-amino-benzene-sulfonamide, or sulfanilamide. Prontosil and a derivate, neoprontosil, however, do seem to have certain unique applications in this field, where sulfanilamide and sulfapyridine are not quite so efficacious, and also are considered by most investigators to be as valuable in general as the less complex molecules.

There are three forms of bacteria: rods, spirals, and globules—all microcopic. The globules are cocci. Occi which characteristically multiply so as to produce chains of globules are streptococci. Staphylococci are those forms which reproduce so as to give rise to clusters of individual bacteria.

Streptococci are man's worst bacterial enemies. They are found practically everywhere, hence are an ever-present

menace. And they cause a greater variety of infections than any other type of bacteria. The most dangerous streptococci are the hemolytic-those with destructive influence on the red corpuscles of the blood. Further, there are numerous strains of hemolytic streptococci, the beta strain being outstandingly diabolical. Beta hemolytic streptococci cause septicemia ("blood poisoning"), mas-toiditis, acute tonsillitis, septic or epidemic sore throat, erysipelas (acute inflammation of the skin), scarlet fever, and several other pathological conditions. Prontosil goes into history as the first drug to be effective against these bacterial invasions. Except in the case of scarlet fever, where serums are now available, no direct treatment, not even a partially beneficial serum, was known to medicine before prontosil and sulfanilamide.

NEITHER sulfanilamide nor any related compound is "a three-day cure" for gonorrhea, which is caused by a coccus that characteristically multiplies so as to produce pairs of hacterial balls and hence is known as diplocousthen ew drugs are remarkably active here too, but weeks are always required for a cure—and a considerable percentage of the sufferers are not at all henfited by the drug. Yet the therapeutic agents have no equal in their powerful action on this occus.

Such successful drugs as prontosil and its active fragment, sulfanilamide, stimulated feverish research among the world's pharmaceutical chemists, Hundreds of sulfanilamide derivatives have been synthesized and tested on infections in experimental animals and on human beings in the clinic. Last year, the English medical scientist, L. E. H. Whitby, published a paper describing his experiments with 64 different molecules, Of these drugs, sulfapyridine showed unique promise, as tested on infections in mice. Generally duplicating, if not surpassing, the beneficial activities of sulfanilamide, sulfapyridine in addition was proved strikingly effective against the staphylococcus, the pus coccus of boils, carbuncles, and most of the other common pus-producing bacterial invasions. Sulfanilamide is practically valueless in staphylococci invasions.

Whitby's pioneer labors have been immensely extended. Sulfapyridine, if it does not ultimately turn out to be too poisonous, is going to be used more and more against staphylococcus and may replace sulfanilamide in many treatments, perhaps in gonorrhea therapy.

In fact, both sulfanilamide and sulfapyridine (and, of course, closely related compounds, such as pronosil) are highpyridine. (and, active drug is a potential posson, because its very activity is dependent upon its power over life reactions. So toxic are these new chemical agents that the government forhilds their sale without a prescription. And, as yet, sulfapyridine has not been released for general sale in drug stores, even if prescriptions were available. Use is re-

stricted—wisely—to the leading medical experts. The experimental phase has not been passed. Great care is exercised with sulfapyridine: experience has taught that the sufferer who treats himself with sulfanilamide is hable to kill limself.

A TYPICAL view of the A tozicity of sulfanilanides that of Dr. Reuben Ottenberg, of the Mount Sinat Hospital, New York City, who usmu pu his study of hundreds of cases in the New York State Journal of Medicine. "We are dealing with a treacherous drug—one that has enormous therapeutic value and therefore cannot be abandoned, which nevertheless, on rare occasions, due to disoyncrasies which have as yet no explanation, may de-

velop the most destructive effects. In spite of the rapid and brilliant cures which can usually be effected, the phyvician should not be tempted to give the drug for minor infections. Sulfaniamide seems to be most valuable against microorganisms which are rapidly spreading, are more or less free in the tissues, or are in the general circulation.

Sulfanilamide and certainly sulfapyridine are best administered to a patient who is kept in the hospital, under close supervision. Almost daily observation as necessary, especially where the patient has not been hospitalized, and is liable to overdose himself against the advice of his doctor, or is liable to develop some sudden reaction.

Reactions are numerous and varied. "Patients who are receiving sulfanila-mide therapy," advises Perrin H. Long, of Johns Hopkins, in *The Pennsylvania Medical Journal*, "should be warned against driving automobiles because the

Right: Girls filling bottles with neoprontosil tablets. Prontosil, neoprontosil, sulfanilamide (terminal syllable pronounced "mid" in spite of spelling), and sulfapyridine are all closely related compounds



Below Filling vials with neoprontosil solution, in glass-enclosed hoods and under sterile conditions and surroundings



dizziness and decreased mental keenness sometimes seen in the course of therapy with the drug render many individuals dangerous on the road "

Other untoward results are rashes, extreme sensitivi to light, sudden severeancuia, fever, headache, nausea, acute acdusis, loss of white blood cells, temporary msanty. But, in experienced, careful hands, sulfaniliamide is not only invaluable but safe—no deaths occur, mad reconvey from adverse symptoms due to the drug is sure and complete. Sulfanilamide already saves thousands of lites annually. And the probability is that sulfapyridine will do likewise.

Toxic manifestations to sulfapyridine copy those caused by its chemical relatives, as is generally the case in physiology. Sulfapyridine may or may not he more toxic than sulfanilamide. Nobody knows for sure, yet—but it is beginning to seem that sulfapyridine is slightly the more dangerous of the two, though

by no mean excessively dangerous. These new agents are prepared as expansion, and interest of the mean excessively administration by mouth is preferred, but impections are necessary in certain conditions, as where the patient's digestive system is upper Sodium beatbonate is invariably given along with the drug, because of the danger of acidosis, And, as Dr. Long and his colleagues repeat: "We cannot stress too strongly the fact that

the patient who is receiving the drug

needs the intelligent and careful supervision of the physician."

IT is now established that the chief factor in successful therapy is the maintenance of a certain rather high concentration of sulfanilamide or sulfapyridine in the body, over a period of days. The chemicals are extremely valuable in that they diffuse almost evenly throughout the tissues and tissue fluids, even penetrating in beneficial concentration into the most secret focus of infec tion, the chief spawning place of the germs. So efficacious are the new drugs, especially in gonorrhea, that recovery is often dramatically sudden-and the germs apparently disappear completely withm a few days. That is why sulfanilamide has erroneously been called the "three-day cure"-and why many a secmingly cured individual may become a walking source of infection, and may himself suffer a new attack from germs not harmed but merely lurking deep within the tissues. Now, with our first wave of over-optimism subsided, we know that no cure is sure unless the case is followed through a full six-month period.

What is the explanation of the action of the new chemotherapeutic molecules? If the drug chemist knew the answer, he could discover whole systems of chemical agents, each valuable in a unique way This mystery is for future research A new era is before us.

COLD LIGHT

FIREFILES have long excited the curiosity of man. The first recorded tetempt to make a scientific study of their light was that of Robert Boyle, who lived in the 17th Century. Boyle placed fireflies under the bell jar of his vacuum pump and gradually exhausted the air As the air supply became thinner the glow became less intense, until finally a point was reached where it died out altogether.

ln our own country, Professor E N. Harvey, of Princeton, undoubtedly is the most outstanding of all investigators in the field of bioluminescence, or light production by animals and plants. Professor Harvey has found that the luminous material of the firefly consists of two chemi-

cal substances, which he terms "luciferm" and "luciferase." Neither of these contains any phosphorus, as is commonly supposed by many persons. They are both protein-like in nature, but their exact composition has never been determined. It seems likely that it is the luciferin which actually produces the light, while the luciferase acts as a catalyst-that is, it stimulates the light-giving reaction to take place, without undergoing any appreciable change itself. The light occurs when the luciferin comes in contact with the oxygen of the air in the presence of the luciferase. The presence of water is also necessary for light to occur. In a dried condition the luminous organs will keep indefinitely. Once the writ er dried about 500 fireflies, then removed and pulverized their luminous organs. Several years lat-

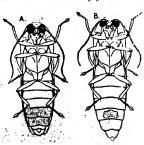
er this powder, when moistened, still would glow with undiminished bright-

The light-giving organs of the firefly pre-ent a marvelously complex structure. They occur on the under side of the last two segments of the abdomen. Just above these luminous cells, embedded in the body of the insect, there is a highly efficient reflector. This consists of a layer of tiny insoluble crystals, so arranged as to reflect the light downward, thus causing it to appear more intense. The luminous cells themselves contain the luciferin and luciferase, and are interspersed with countless numbers of tiny air tubes. At the time the insect flashes, air is forced temporarily into this complex network of tubes, and the oxygen reacts with the light-giving compounds, producing the If Man Can Discover the Secret of the Firefly, the Effect will be Far-reaching... Experiments in Which Man Tries to Imitate Nature's Successes

By EVANS W. COTTMAN

light. An injured firefly will sometimeemit a continuous glow, and this is lecause the organs controlling the admission and expulsion of an have been impaired, allowing a constant small supply

of oxygen to find its way into the tubes. The question is often asked: Of what use is this light to the firefly? The light serves as a means for bringing the sexes



Countery Dr. Unic Dahlgren and the Journal of the Fronklin Institute
Location of luminous organs on under side of firefly, shown by shaded areas. A is the female, B, male

together. Each sex and each speeces has its own characteristic light and its own methods of flashing. Some have a yellowin flash, while others have a bluish green. Likewise, some flashva are luisk green. Likewise, some flashva are long and deliberate, while others are quick and nervous. Professor Ulric Dahlgren, of Princeton University, some years ago devised a tiny electric flashlight with which he was able to imstate the color and style of flashing of various types of fireflees, and with this he was repeatedly able to attract large numbers of male freflies by mitiating the females' flash.

The eggs of the firefly are laid in late spring or early summer, around the roots of grasses in damp, moldy places. At the end of about 22 days, the luminous organs begin to develop within the eggs and the eggs begin to glow. These hatch

in midsummer into tiny luminous grulis, the glowworms. The glowworm is the larva of the fively, just as the caterpillar is the larva of the thefty, just as the caterpillar is the larva of the butterfly. (The name is also applied to the adult wingless formaless of some species). Glowworms hidduring the day, but emerge at night to seek food, then diet consisting chiefly of nails, slugs, cutworms and small earth-

worms. For two summers they eat and grow, but hibernate during the winter. The third spring they emerge again and shortly afterward pass into the nupa stage. Inside the shell of the pupa case wings develop and the light-giving organs change into the adult form. At the end of about 17 days the adult firefly emerges. Shortly afterward it mates, the eggs are deposited and, after a brief life on the wing, the insect dies. The glowworm can easily be distinguished from the firefly at night by its continuous glow, whereas the firefly emits its light only in flashes. Also, the glowworm does not fly. In the glowworm the entire area of the segments of the abdomen do not give off light, the luminous areas being limited to tiny spots.

Interesting as our own fireflies are, others in foreign lands are more spectacular. In South America there is a species called locally the automobile bug because it has a white light in front and a red one behind. In New Zealand there is a large underground cavern, its walls and ceiling frequently covered with millions of glowworms. The interior of the cavern is well illuminated by them. The Sumatra glowworm is famed for its brilliance, It possesses 38 spots of light. One species of beetle in South America gives such a brilliant light, that it is sometimes collected by the natives for illuminating their homes.

Besides fireflies, numerous other animals and some plants give off light. Any one living near the ocean has probably at some time noticed a dead fish, in the early stages of decay, emitting a greenish light after dark. This is caused by a certain type of marine bacteria. A story is rold of a butcher whose shop sequired the reputation of being haunted. The means had become infected with luminous bacteria and glowed at might. These bacteria can be artificially grown in a suitable height clutter medium. They cent a constant steady light which attains its maximum in about two days. This light serves the bacteria in no way known to man, if at all, and secure to be merely incidential

Batteria cannot be stimulated intoemitting light by mechanical shock, electric shock, or heat. A slightly alkaline condition is more favorable for light production and no light is ever present in an acid medium. Batteria have been concentrated into a small space by centrifuging

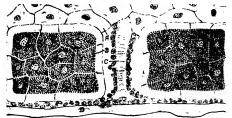
-whirling them about at a high rate of speed Such concentrated suspensions of himmous hacteria glow with greatly increased brilliance, cruiting sufficient bight to enable one to read print at a distance of several feet from the high

Human perspiration and the urgo animals have been observed on rare occasions to glow in the dark. Centrally this has been ascribed to the presence of bacteria accidentally taken into the stomach on food. While this may be the case, the writer has found that various exerctory products are themselves luminous when properly oxidized.

Many mushrooms and other fungicoustain substances which glow when exusion stores which glow when exposed to air, Especially is this true of the insection, or network of fin threadther tissus, from which the mushroom grows. This asychim permeats the decayed wood from which they may appear and, of if the wood be torn apart, the fibers of of if the wood be torn apart, the fibers of or the mycchim are broken, exposing their contents to the air, This causes the glow called forshire, which often has been observed on dann, rotten wood.

In many localities the sea contains myraids of Northea, bittle one-celled animals which will entit light when disturbed. A boat passing through such water leaves a wake of golden light, due to the disturbance of these organisms. The sands near the shore are left saturated, when the tide goes out, with water containing these tmy living forms. Treading upon these sunds disturbs them, and thus footprints of golden light are left impressed upon the sand.

The luminous deep-sea fishes have long been a source of interest and wonder and many articles have been written on them alone. Some have rows of lummous spots unning along their sides, gring them the appearance of miniature ocean heres at night. Perhaps the most interesting is the deep sea angler. This fish has a long stalk extending out from its head. On the end of the stalk there is a "light bulk," surrounded by little appendage which look like worms. This luminous device hangs just in front of the fish's mouth. The light and the "worms" attract small-rakes, which of course places them in



A highly magnified section through the luminous organs of a firefly, A represents cells of the reflecting layer, B, luminous crofts, the little dots being granules of his ferim C, are tube admitting one for to luminous cells, D, transparent skin over the lower surface of the luminous segments of the abdomen. The light produced in the cells B is reflected out through D by cells A, as is described in the text

the most convenient position for the large fish to swallow them

Among other luminous forms of animal life are numerous kinds of jellyfish, sponges, marine worms, carthworms, centipedes, brittle stars, mollirsks, shrimps crabs, cuttlefish and squids, the total number of species running into many thousands. One species of squid has luminous organs on the ends of its tentacles. It flashes these like a firefly. One of the most brilliant of all luminous ammals is Cymodina, a small marine ostracod crostacean. In this animal the luciforin and hiorferase are discharged into the surrounding water, producing a brilhant blue binimescence, Dr. Harvey used this animal extensively in his researches.

SINCE nature has supplied cold light me no may forms, it is natural that man's interest should be stimulated, and that he should try to mintar hes. In 1877 the chemist, Radiosewski, prepared be plune and decovered its luminescent properties when oxidized Lophine gives aboutfully clowled light Directions for its preparation and treatment have been stated in Secuntific American Juggists, 1937, page 120—Ed. | The witter has prepared about a dozen directive to lophine, most of which have been luminescent.

An orange-red luminescener can be produced by treating pyregallol (commonly used in photography) with for maldelyde and hydiogen peroxide in stiong alkaline solution. Dr. Harvey produced light by oxidizing pyrogallol with peroxide and potato juice.

In 1923 W. Evans and R. T. Dufford

In 1923 W. V. Evans and R. T. Dufford described a series of luminescent compounds which they had prepared. These belong to the class known chemically as Grignard compounds, and one of them, p-chlorphenylmagnesium bromide, gave the brightest chemi-luminescence that had yet been produced. In 1929 the German chemist, Albrecht, discovered a chemical which, when oxidized, gave forth the most intense and brilliant cold light thins far known. This chemical has received considerable at tention in this country, and much irresarch work has been done on it by Di. E. H. Hantiess of the Massachusetts. In stitute of Technology, The chemical name of this compound is 3 ammophitallydratacle. For convenience Dr. Huntress has proposed the tenm "Hummoh" Upon oxidation it profuces a brilliant blue cold light which makes a striking display when demonstrated before an audience.

The writer has developed a luminol preparation in a dry powder form termed 'chemglo'. As this powder contains the correct oxidizing agents, it is necessary only to add it to water in order to produce luminescence. An accompanying photograph was taken by chemglo cold light.

One would hardly expect to get light out of sugar, starch, and such compounds, but that is what I am doing in my laboratory. This type of compound does not itself give visible light upon overlation, but does so if heated or flused first, and then oxidized. The following compounds have been subjected to this treatment with positive results: cance sugar, glucowe, levulose (fruit sugar), a lactices, emils sugar), galactives, starch, deatrin, gum arabic, tartaire, laetic, male and cittue acids. Eme airre acid seems to offic exceptional possibilities, as the flash from it is unusually brilliant.

The odd light described thus, far he longs to the class known as chemician necence. It is in every case caused by chemical action—the oxidation of somehemical compound, usually organic Their air, however, many other types of old light, some of which have been studied much more than chemi-lamine-conec. When an electrical descharge is sent through a vacuum tube containing traces of various gases, a brillant cold



A photograph taken by light produced by a luminessent chemical in solution in the nearer vessel illuminating the other Kodak Bantam Special, 10 min., f 2

electro-luminescence may occur. Radium, reused on the dials of "radium" watches and clocks. Grystallo-luminescence is the emission of light when certain substancecrystallize from solution. Tribo-luminesence is the production of light when some kinds of crystals are mechanically crushed. Bio-luminescence is applied to the light given off by animals and plant; it is a kind of chemi-luminescences.

LUORESCENCE occurs when light Pluorescence occur is changed and emitted as another color. Fluorescent substances may appear brilliantly colored in the dark when exposed to ultra-violet rays, the so-called black light. These colors immediately disappear from a fluorescent substance when the black light is turned off, but if the light persists for a time after the ultra-violet rays are removed, the phenomenon is called phosphorescence. A phosphorescent nun eral may glow for several hours after having been exposed to sunlight. The term was originally derived by suggestion from the element phosphorus, which glows in the dark. However, in the present sense, it is a misnomer, as phosphorescent substances have nothing to do with phosphorus. It was formerly thought that fox-fire, and all lights produced by animals and plants, were in some way connected with phosphorus. This has been found untrue, and the term luminescence is used in place of phosphorescence for describing this phenomenon.

One of the most surprising discoveries in the realm of cold light has been made by Dr. Leslie A Chambers, of the Johnson Foundation for Medical Physics in the University of Pennsylvania. He has produced visible light by means of sound waves. He places a powerful vibrator in a liquid and causes it to where at a high

frequency. When this is done many liquids emit light. He reports that viscous liquids at a temperature of about 77 degrees, Fahrenheit, are most favorable for this type of lumnescence, which he has termed acoustico-luminescence. He produced his brightest light from glycerin, which is very viscous.

The first question asked by the practical reader after all these considerations will be: "What use can be made of cold light?" At present we must admit frankly that we do not know. The study of this subject is in its infancy; the phenomenon is, as yet, regarded as a laboratory curiosity. Yet, practical-minded scientists are continually lifting just such labora-tory curiosities out of the realm of pure science and finding applications for them. It is certain that Oersted could never have dreamed of electric motors, telegraphs, and our long list of electromagnetic appliances when he was making his first interesting studies of the relation of magnetism to electricity.

Cold light seems to have certain theoretical possibilities. It is the most efficient light known. Most lights expend from 95 to 98 percent of their energy in the form of useless heat. Cold light, on the other hand, expends from 90 to 98 percent of its energy in the form of pure visible light. There is scarcely any perceptible heat loss. The intensity of the light, however, is so small that it would require a large light-emitting surface to illuminate a room thoroughly. The present costs of materials would make such a method of illumination impracticable. It will first be necessary to discover brighter and cheaper cold light chemicals.

Occasionally in newspaper articles the claim is made that the secret of the firefly has been discovered. Such articles nsually have reference to luminol. This is, indeed, a brilliant cold light preparation, but is far from being the answer to the firefly's riddle. If the secret of the firefly were really to be discovered, the effect would probably be far-reaching. The firefly is one of the most efficient organisms in the world. Not only is its light efficient from the standpoint of visibility, but in economy of fuel consumption it is even more remarkable. When the insect flashes, its luminous material is oxidized, giving off light. During the time that the organs are dark, a reversal of this process takes place, and the products of the oxidation are reduced back to their original condition, ready to use over again, It is much as if one could burn a log, then catch the smoke, gases and ashes, and put them together to remake the log.

Possibly cold light will prove to have more uses in the field of medicine than in illumination. I have obtained light by the oxidation of urine and a number of the isolated products of metabolism, Also I have frequently used blood to oxidize such compounds as lophine and luminol. A very good light can be produced from the oxidation of urine by blood, in alkalme peroxide solution. In the laboratories of the Eli Lilly Company I obtained measured amounts of blood from an anemic gumea pig, likewise from one which had been rendered normal by giving it liver extract. The two samples of blood were used to oxidize lophine. A very perceptible difference could be observed in the amount of light, the latter sample being the brighter. While little has been done in this direction, it seems quite possible that a technique might be developed for using such phenomena as an index to certain physiological conditions, If these physiological lights could be amplified and made the subject of intense spectroscopic study, the horizon of possible applications would be immeasurably extended

DR. GEORGE CRILE, of Cleveland, has made some investigations in the field of physiological radiations. He has caused animal brain tissues, reacting to chemicals and gland secretions, to give off visible light. Dr. Crile feels that the luminescence affords experimental evidence that the brains of animals and man may produce their own light, and "that the sun shines again in the proto-plasm of animals." He believes that consciousness and such mental processes as thinking may somehow be connected with these mysterious emanations from the brain's supremely delicate tissues. It seems quite certain that all the materials necessary for luminescence are present in the human body. Normally, these are not brought together, but if this were to occur abnormally, it might explain the occasional luminosity reported as occurring in certain rare individuals -- a woman in Italy, for example,

Color on a Huge Screen

N a continuous flow of glowing color, single scenes or groups of scenes fill the 187-foot long screen that is part of the Eastman Kodak Company's exhibit at the New York World's Fair This gi gantic display of modern color photogra phy is made possible by new twin prosectors. 11 of which are concealed in a projection booth just under the roof of the hall. Through each of their gates stabs a brilliant beam of light Tiny colorfilm transparencies, about 1 by 11/2 inches, made on standard Kodachrome film, pass these gates-to become full-color screen pictures approximately 50,000 times larger than the originals.

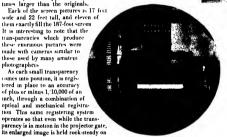
Each of the screen pictures is 17 feet wide and 22 feet tall, and eleven of them exactly fill the 187-foot screen It is interesting to note that the tran-parencies which produce these enormous pictures were made with cameras similar to those used by many amatem

photographers As each small transparency comes into position, it is registered in place to an accuracy of plus or minus 1/10,000 of an inch, through a combination of optical and mechanical registration This same registering system operates so that even while the trans-

the screen-no motion can be detected Each of the hidden projectors is synchronized with the others by an electrical interlock-operating through a fully-automatic control system. Through its electrical interlock and control mechanism, the projection system can be operated with infinite flexibility. If desired, pic-

tures can be changed at different speeds -one group of pictures remaining on the screen a half-minute while others are changed up to four times a second. Fades. dissolves, motion effects can also be presented

The "heart" of the projection system control is a specially notched sound-film, which not only carries the voice of a commentator and special musical accompani-



Top, right. One of the twin projectors, partly assembled Behind the lens at the left is shown one of the lamp houses and heat filter. In circle The rectangular piece of optical glass that registers the film transparencies exactly. In this view, the film slide is slightly high in the gate; the registering plate is automatically tilted to provide cor-rection. Left: Bolting the slides on the "drum" gear

ment, but also regulates the movement of the projector shutters and the shifting of slides - keeping pictures and comment

in perfect synchronism.
Employed in the projectors are large fine-pitch precision ring spur gears, each one 45 inches in diameter and carrying 1440 teeth, On these "drum" gears are



bolted glass-mounted color transparen cies-96 pictures to a drum, Twenty-two gears are used in the 11 twin projectors. so that the system carries 2112 color-film pictures ready for automatic projection

To link the gear-rings with the automatic indexing system, the projector-employ one of the largest single-step spur gear reductions ever attempted-48 to 1 The 45-inch gears work directly from a 15 '16-inch pinion

E ACH color slide carries a series of gear teeth, integrally mounted along it- edge. Together, these teeth form a continuous series around the film ring, and serve to operate the optical registering system built into each film gate This registering means consists of a small rectangular plate of optical glass, which spins as the film ring rotates. As each picture moves into position, this glass wings upright before it. If the picture halts a trifle too high in the gate, the registering-glass remains tilted slightly forward at the top. If the picture stops too low in the gate, the glass tilts back correspondingly, its movement being controlled by the gear teeth on the film. In either case, refraction through the glass shifts the picture-image so that it travels at proper level through the lens, and is correctly positioned on the screen.

The illuminating system of each projector is centrally housed, with the ring gears and film drums revolving around it Water cells are used for cooling, and in addition, a blast of air, chilled almost to the freezing point, is directed on each projector gate. Large-aperture, long focus projection lenses are used, and spe cially designed shutters are utilized for many screen effects.

WHAT KEEPS THE STARS SHINING?

WE told last mouth how it can be shown, from the general properties of matter, that a large mass, iso of matter, that a large mass, iso lot inside—millions of degrees, how the leat must except slowly to the surface, and keep this meand-scent, and how the beserved relation between the mass and the real brightness of a star has thus been fully explained. But the great question why the stars keep on shining remained.

Helmholtz and Kelvin were undoubtedly right in saying that such a gaseous mass, if not otherwise supplied with energy, would slowly contract, drawing on gravitational energy, converting it into heat, storing half this heat or more in its interior, and using the rest to maintain its radiation. But the Sun has been warming the Earth during the whole of geological time-that is for more than 1500 million years, and in this long interval it must have got rid of a hundred times more energy than gravitational contraction could supply. The Sun, and the stars in general, must therefore have some internal source of energy far greater than thus.

This would have been perplexing indeed, had not the very same physical discoveries which revealed the problem pointed a way to its possible solution. It was from radio activity that the evidenceeme which showed conclusively that individual crystals of minerals had lain in the rocks for more than a blittle space, in since their formation; and it was radioactivity, too, which revealed the existence of vast and previously unimagined stores of energy lock dup within action.

To the minute atomic nuclei, therefore, we had to look as the only places one, we had to look as the only places small enough to hold so much. (This is not a paradox, but a way of deserbing the enormous magnitude of the forces which act at these minute distances.) The obvious suggestion that there were radio-active substances inade the stars, which liberated the heat necessary to keep them going, might account for a life of billions of years; but, unfortinately, when it was followed up, it dduft work.

To begin with, radio-active atoms the cate energy at a rate which quite in-dependent of external conditions—temperature, pressure, and the like B₃ assuming the presence of a certain calculable amount of uranium (for example) in the Sur, we can account for the maintenance of its radiation—though the percentage of the whole mass came out rather high. But the more massive stars are much brighter, and radiate

For the Source of Stellar Energy We Must Look To Reactions Between Charged Atomic Nuclei . . . Discussions and Background for Bethe's Theory

By HENRY NORRIS RUSSELL, Ph.D. Chairman of the Department of Astronomy and Director of the Observatory at Princeton University Research Associate of the Mount Wilson Observatory of the Carnage Institution of Washington

much more energy in proportion to their masses. To match this by radio-activity, we would have to assume that the amount of active material had been, in some strange way, so adjusted that the massive stars contained a larger percentage. and those of small mass a smaller, exactly adjusted to meet their needs. It is not necessary to assume (as one would think) that the stars were purposefully made in this way. A star with too little active material to supply its inevitable losses would draw on gravitation for the test, and shrank; one with too much would be forced to reverse the history imagined by Kelvin, and expand If the Universe is old enough, the under-supplied stars might have shrunk out of sight, and the over-supplied expanded into nebulosity, leaving only the wellbalanced ones to be counted But this is hard to believe.

WE do not have to try, anyhow, for another objection to the radio-active theory turns out to be fatal.

A more detailed calculation of the theoretical luminosity of a star shows that, for a given mass, it increases slowly with diminishing size Suppose, then. that there was a perfectly adjusted star, of given mass and radius, and that, in any way, it became a little smaller It would then be a little brighter, and lose more energy. But the radio-active supply would be just the same. It would draw on gravitation for the balance, contract, and get more out of adjustment than before Things would rapidly get worse, and the star would contract "out of sight." If, on the contrary, it should be slightly expanded above the ideal size it would be supplied with radio-active energy faster than it got rid of heat, would be forced to expand further, and again would run wild. A star supplied by an atomic energy source at a fixed rate would therefore be inherently unstable The process of "running wild" might take a million years (more or less) to get well going, but would be mevitable.

We can get away from this trouble by

a-suming that the otherwise unknown at atomic-ory sub-atomic-process depends in some way upon collisions between the atoms, and not on happenings in the interior of an isolated atom (as radio-activity appears to do). We should then expect its rate of occurrence, among the same unabler of atoms, to increase with the density, since the atoms would cold help offeren, and expectally with the temperature, since the collisions would be offeren, and expectally with the temperature, since the collisions would be more violent.

Now suppose that we had a star out of adjustment, with the atomic process supplying too little energy. It would draw on gravity for the rest, and would contract. This would make the gascons interior denser, and, as we saw last month, also raise its temperature. The atomic process would then supply more heat. If (as is very probable) this gain in income exceeded the (rather moderate) gain in outgo from the surface which accompanied the contraction, the star would be nearer a balanced budget after the contraction than before. There would be a certain size of the star at which in come and outgo were equal. This would give a state, of equilibrium, and, this time, the state would be stable. Suppose that the contraction overshot the mark Too much heat would then be liberated, but this would force the star to expand, make the interior less dense and cooler. and shut off the over-supply. A star fed by an atomic source at a rate increasing with temperature and density would therefore be self-regulating; it would automatically seek and find a balanced state, in which just enough heat was liberated to supply the natural flow to the surface.

One further complication has to be considered. Suppose that we started with a star that was not quite in mechanical equilibrium—say a little too large, so that the innernal geopressure did not balance gravity. It would contract, overrun the neutral point, as such things always do, get too small, be impelled to expand, and so find itself in a state of oscillation or pulsation, changing in diameter with a regular period. Edding. ton showed, years ago, that the flow of heat from the hotter to the colder parts of the gas would have a "damping" effect on such an oscillation, gradually reducing its range to nothing—as the friction of the air does to a pendulum.

But, if the heat-supply increases rapidly with temperature, most of it will be liberated when the pulsating star is smallest. This is equivalent to giving the outward motion afterward a little push at every oscillation, which tends to increase the range, If the damping effect predominates, the star, if disturbed, will settle down into quieseence; but, if not, a pulsation once started will increase-probahly not enough to break up the star, as it is likely to be limited in extent by additional influences. Many stars are known-the Cepheid and eluster variables-which appear to be doing just this, but the vast majority of the stars are -teady-going affairs of fixed diameter Hence our theoretical source of energysupply must not increase too violently with the temperature.

At one time this appeared to be a toublesome limitation. But, a few years ago, Cowling showed that, if the rate of heat-production increased rapidly with the temperature, there would be a convertive region, near the center of a star, where currents of heated gas would be issing and cooler gas from farther out descending to take its place. He concluded that, under these conditions, the instability which leads to large pulsations would not occur unless the rate of correys-liberation increased faster than the 20th power of the temperature—which affords a pretty good margin.

So much we can learn from the stars themselves—about the properties which the energy-liberating process must have, if it is to satisfy the astronomical conditions.

WHAT processes of this sort could occur in Nature we must assume, if we can, by appeal to physics—and physics of a very modern sort

Our first aid comes from relativity the general relativity which is Einstein's greatest achievement. According to this, mass and energy—previously supposed to be each separately "conserved" and nodestructible—are convertible one into the other, at such a rate that m units of mass (grams) are equivalent to me? units of energy (ergs)—where c is the velocity of light.

Theoretically, then, the mass of a body should be increased by heating it, as o adding energy to it. The reason why this cannot ordinarily be measured is 10²⁰), so that a very large amount of energy, measured by everyday standards, corresponds to an excessively small mass. For example, a too of iron cooling from its melting point to ordinary temperatures liberates heat equivalent to 150

kilowatt-hours of energy, its mass is diminished by 1/160 of a milligram!

When we come to astronomical figures, we find that the Sun radiates into space 3.78×10^{33} ergs per second. To say that this rate is equivalent to 5 x 1023 horsepower conveys no real significance to us, whether we write out the 23 ciphers or not; but when we divide by c2 we find that the Sun is sending out 4,200,000 tons (metric) of heat into space every second, or 1300 millions of millions of tons every year At first glance this looks a little alarming llow long would it be before the Sun was used up, at this rate? We need not worry, the Sun's mass is 198 x 1033 grams, and it would last 15 x 1013 years-15,000 billion.

For the source of stellar energy, then, we must look to some process which changes the mass of atoms, and liberates a corresponding amount of energy When this was first realized, more than a decade ago, we had a free choice between two hypotheses-because there was no experimental evidence at all on the subject One was that, in some way, atoms were annihilated, while all the energy corresponding to their mass was set free, the other, that atoms of one kind changed into another, with a net diminution of the total mass, and liberation of energy. At the present time, we have pretty well stopped playing around with the first idea, for the good reason that it remains purely speculative, without any direct evidence in its favor (so far, at least, as regards ordinary atoms) The second notion has meanwhile advanced from the status of a hypothesis to that of an established fact With the aid of the natural projectiles emitted by radio-active substances, and the artificial ones accelerated in evolutions and similar devices, an amazing variety of nuclear reactions has been produced in the laboratory. Dozens of new kinds of artificial atoms have been made-some of them in several ways-by breaking down or building up from familiar ones Atomn masses have been measured with great precision by the mass-spectrograph, the energy liberated in the reactions has also been measured, and by comparing the loss of mass with the liberation of energy it has actually been possible to calculate the velocity of light from Einstein's formula. The result is of no great percentage accuracy, but it fully justifies the claim that the equivalence of mass and energy is now a fact proved by experiment

All these reactions occur between the imp nuclei of the atoms; on their scale, the outer electrons are merely distant satellites, remote from the colliding particles, and not directly affected by what happens to them. They fall into two general classes—concounters between charged atomic nuclei and neutrons, and hetween two charged nuclei.

Most of the reactions which have been

produced in the laboratory are of the former type-for the simple reason that the atomic nucleus and the neutron neither attract nor repel one another (except at very small distances, indeed), so that a neutron which happens to be moving almost directly toward a nucleus stands a fair chance of getting near enough to it to do something, even if the nucleus is heavy, and has a large charge. But two nuclei, being both positively charged, repel one another. Even a hydrogen nucleus (proton) with its single unit of charge, is so powerfully repelled that, unless its original line of motion was directed almost absolutely straight at the nucleus, it would be deflected to one side, and would miss it Even if it were correctly aimed, it would be slowed up by the repulsion, stopped, and sent back along the same path, without getting near enough to do any damage, unless its initial speed was very high.

THE very thing, however, which makes neutron-reactions the delight of the laboratory physicist makes them unimportant for the astrophysical theorist. Such reactions happen so easily that, in the interior of a star, a free neutron would not remain free for a thousandth of a second—long ere this, it would have hit some atomic nucleus, gone into it, and either built it up into a heavier one or broken it into pieces. If any of the pieces were fresh neutrons, the process could go on repeatedly-and perhaps explosively, but, so far as present observation goes, this does not happen The neutron is used up in the reaction, and only charged particles come out of it.

Hence, if there were any number of neutrons in the Sun now, there would be practically none a thou andth of a woond afterward We could move them, and the reactions in which they take part, as permanent sources of energy only if "new" neutrons were continually being produced, inside a star, by some sort of reaction between chaiged nuclei. To anticipate a bit, it may be said here that the possibilities of such processes have been exhaustively explored by experts, only to find that they would occur, if at all, so very rarchy as to have no practical effect

Fon the source of stellar energy, we must therefore look to reactions between charged atomic nuclei. Here a notably successful throw has been developed by Professor Bethe of Cornell, along lines resulting from the recent work of Gamow and others, and the poment theory which Alkinson suggested several years ago, before neutrons had been discovered and while nuclear physics was still too young to permit us to follow out the various processes in detail. But again space falsi, and our story must he "continued in our next."—Princeton University Observators, April 5, 1939.

THEY NEVER SAYNO'

"Prop" Men Furnish the Thousands of Odd Items That Make Motion Pictures More Realistic

By ANDREW R. BOONE

"M EMO to prop department On Stage Four, nine o'clock Thursday morning, one Statue of Liberty, carved out of ice; double for Charlie McCarthy; mouse complete with hole, one blue snake dressed like a cobra, dummy camera, 100 ruibber arrows."

Irving Sindler, veteran Hollywood preperty ward, read the order, whistled softly and set to work Instructions sped to assistants, but the took over the most exacting job linned!. Bending alone over a huge cake of nei in a Los Angeles cold storage plant, he worked through the night and next morning at sump packed the little statue in heavy burlap bags, surrounded time with dry lee and drove across the city to the studio. When the principals were ready for the scene in "The Cowboy and the Lady," Sindler set the statue on a base of mashed potators, which doubled for ree cream, and placed at un front of the camera.

Sindler is one of those unknown wizards of the screen, the proporty men who must have within reach every manner of thing, from crooked dice to synthetic blond, or be able to find or make overnight whatever the director demands, no matter how outlandsh it may be or difficult to produce. Items numbering in the thousands are constantly required.

Hollywood property crudents required. Hollywood property crudent what contraptions may be demanded next. Early one Sunday, a director decided he must have a "prop" mocking bird for several closeup seenes. Not only did he order it delivered Monday morning, but the little hard must be able to move its head and beak as though in song, flat its winney, flirt its tail and ruffle the feathers on the neck. One day for the bird of the state of the sunday and the sunday and the sunday and the sunday and the sunday the sunday and the s

In modern motion pictures, the property man has become an integral part of the production. He is repossible for all the formatine, fearn-shings, and things used or carried by plays the goutleman pulls: a handle-truther from he pocker for a specified piece of husiness, that handkerchief becomes a "prop," and no longer is part of his wardrobe. A property man refolds it.

Were you to visit the property depart-

ment of any major studio, you would find the most amazing collection of 'things' ever brought together. Cigar store Indians rub ellows with a replica of the Grand Llama of Tibet Machine guns whell once fred acros. No Man's Land in the World Wai, revolvers made of rubber, crooked diev, and "faxed" roulents where's keverthing ever used once in a

Many other things are not what they seem in the movies Fruits and vegetables for instance, dinner ware, glasses, pictures on walls, and windows. Not only must the property man keep ample supplies on band for eating sequences; it a up to him to preserve them through long, but days under the brilliant lights. He sull-ace lettuce to keep it frob and stiff, sprays fruit to descurage flues, changes the water on cut flowers serve two hours

THESE Jacksof-all-trades also assist the camera man by Alling highlights instant-drying liquid wax and putty kill reflections from glass-covered pictures And between sense involving glass doors or windows, the property man pastes long strips of black paper on the glass, to warn roving actors and technicians against walking into trouble.

Should you look over the shouldes of a property man into his case of prop, you dind an amazing collection of knick-knacks, Labels, theater lickets, husmescards, bank checks from all countres, ink, manicuring servors, harmonicas, candy, slugs to serve as money, blood (glyverine and earmine powder), knew pads for falls, fuller's earth to make dust, airline and railroad tickets, candles, and meedles are only part of the long hat.

Most unusual, perhaps, of all demands on the property men was an order for an acre of cogon grass weed with which to dress a tropical scene for The Last Frontier." None was available in the United States, and the U. S. Department of Agriculture refused permission to import the plant. An ingenious handler of props solved the problem by securing permission to those the problem by securing the permission to those the problem by securing the permission to the proper solved the problem by securing Cupper plane, on the strength of his guarantee to keep the permissions weeds cut before they came to seed. And he had to destroy the plants by burning when the picture was completed.





Above: Property men scoured Los Angeles' and San Francisco's Chinatowns for utensils and decorations seen in these Chinese junks, which floated on an artificial lake

Below: On one large outdoor set, 28 large palm trees were included in the property order. One of the trees is shown here being carried to location by a small hoist



Laft: A dummy camera, a sponge rubber microphone, and part of an order for one hundred rubber tipped arrows. All were turned out in a week by one property man





Right: A portable cabinet. Hundreds of items must be furnished by the property department for each picture



Section of the sectio

Below: Irving Sindler painting celery with shellar to preserve it under the lights of the movie set. Parts of fruits and vogetables to be eaten are carefully marked. Those sections are left untreated, so the shellar will not be eaten



A miniature Statue of Liberty was carved in ice for a dinner party scene in a recent picture. Wooden "stand-in" is at right



Below: Often for larger pictures, property men rehearse their jobs models. The models may or may not be used in the actual-file





DIGEST MONTHLY

FOOD IN A BALLOON

THE latest transparent food wrap is rub ber, and it has fulfilled its principal purpose long before it reaches the cetallers' shelves, with its sales appeal 'purely concidental," according to the Industrial Bul-

letin of Arthur D Little, Inc. The name Cryovae will be recognizable to our classical race of food venders as possibly meaning "cold and empty" Such an unorthodox trade name is descriptive of the

Vacuum nacking -in a balloon

history of the new wrap before it is put on sale. In its original form it resembles a deflated, wide mouthed toy balloon. It is blown up, however, by stretching the web mouth over a frame and drawing a vacuum around the outside. It thus takes the shape of the cylindrical container into which it has been drawn and the chilled sides of the contamer "freeze" it into the larger size. Into such an open-end package is dropped a broder, a vacoum bose removes the inside air and draws the wrap close to the contents, then the neck of the balloon is twisted and clamped to make the whole vacuum pack air-tight Then comes the trick the package is immersed in warm water to "thaw" the balloon, it attempts to shrink to its original size, and stretches to a tant, transparent wrap around the plump chicken

Various potential advantages for such a food container are obvious, and Dewey and

Contributing Editors

ALEXANDER KLEMIN In charge, Damel Guggenheim School of Aeronautics, New York University

> D H. KILLEFFER Chemical Engineer

Almy claim to have realized many of them without most of the possible objections. A special latex rubber was necessary, with no sulfin. Special equipment was designed to reduce the handling time in packaging to a nomt well lo bow that for many other wran-Formulas and production technique devel oped in the manufactors of latex sounding balloons were required for the necessary low cost, strength, and so forth bleidentally, in the chilled, expanded form, the rubber has surprisingly great strougth. Most of the advantages claimed are due to the chimination of an or to the complete moistnee tightness Pork products, for example, are said not to develop rancialty in the fat, clinkens to show no "freezer burn," the bane of low temperature preservation of poultry Prevention of moisture loss not only preserves the original weight, but reduces frosting of cool ing coils in the p frigorating units, and in reases their freezing efficiency

Bags for poultry are designed as one trip outainers to be removed by the consumer Larger bags are intended for the storage of scasonal surpluses of green hams, pork louis, and the like, which are temporarily frozen and released for the market as needed. For these purposes, the latex bags can be washed, shrunk and reused several times. The largest bags are being designed for use with quarters of beef, yeal, and lamb careasses, and are expected to find their principal market in the export field A big for a 350-pound side of best is said to be a practical possi-

RUBBER LUBRICANT

MAY (ERINE has been proved to be an J perior to mineral oil lubricants for rubber tubes and other rubber prices for surgical use by a long series of severe tests Comparison between mineral oil and glycerine was made by coating tubes with each of these fluids, washing with some solution

Conducted by F. D. Me HUGH after five minutes, ruising with water and hually boding five minutes to sterilize them Rubber takes labracated with oil were no fit for use after 37 such cycles. After 200 builings, those lubricated with glycerine were still firm and usable. The bibricating action of each is satisfactory -- D. H. K.

PILOT VALVE

NEW industrial development by Schrader's Son, known as the Pilot Valve, is designed to give a delayed or probuged blast of air for ejecting work from a press, after the ram has stopped its opward motion, it is especially usoful on manually fed presses using overhead knockout or compound dies

The duration of the air blast may be regu lated by a simple serow adjustment on the valve It is easy to serve e and saves money by conserving air and channating the necessity of interchanging machine parts to achieve the results of a timed blast of air With vent closed, it may be used as an air control valve on any mechanism

TENSION WRENCH WITH FLASH SIGNAL

[N the assembly of many products, and particularly in the automobile industry, it is often necessary to tighten unts and holts to a uniform tension. Wrenches with needle gages and others which produce a click when a certain tension is reached have been used in the past, but both types have their disadvantages in dark or noisy corners of factories. The Blackbawk Mann facturing Company solves this problem with a wrench called the Torkflash, which flashes



When the correct pre-set is applied to the handle of this new wrench, a signal light flash-

a signal light when the pre-set tension is

No mathematics is necessary to operate this wreach as the required tension is easily set by the five-in-one scale which slips over the cylinder enclosing the flash-light as-embly at the base of the handle grap. This cylinder is rotated by finger pressure to show desired scale.

Torkfissh has been tested at a capacity raing of 1400 inch-pounds for 870,00 mechanical pulls without affecting accuracy or strength of the wrench up to that point. Used at the usual range of 800 inch-pounds, it has been tested over 130,000 times and full accuracy has continued after that point.

ICE-COOLED MACHINE GUNS

N EWEST use for dry ice is as a coolant for machine guns A detachable jacket, filled with dry ice and slipped over the barrel, keeps the gun continuously cool The scheme enables fighting planes and bombers to carry fewer guns, yel to maintain continuous fire.

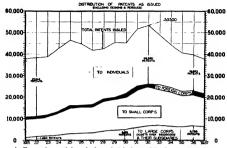
To Develop a LIFETIME TIRE

WITH child sized machines, serutists of the Fisk Tire Company are working in a miniature rubber plant to perfect the tire of the future that will carry automobiles along super-highways at 100 miles per hour

The musture plant duplicates in every detail the grant featory methods used in standard manufacture. There are hus of compounds, mills and calenders for musing tubber, a series of vulcanuers and preservable and the series of successive and preservable of the series of

Purpose of the miniature plant is to facilitate research work, speed operations by working with small quantities, and climinate unnecessary waste.

Today these scientists are looking toward 1950. The future tire, they say, will be lighter and tougher, with greatly improved safety features. The careass will be stronger to stand greater temperatures of high-speed operation. With decreased weight through



An illuminating graph from the Journal of the Patent Office Society, which shows the total number of patents issued during each year, from 1921 through 1977. The distribution of these patents between individuals and responsitions is particularly striking. It will be noted that, despite the impression that large corporations are obtaining the preponderance of patents issued doaty, their percentage is relatively small in comparison with the number of patents issued to small progressive cosporations as well as to individual inventors

redistribution of materials and through improved materials, greater flexibility will be secured, which in turn will provide better riding and wearing qualities. Treads will be tougher to stand up under increased mileage.

Eventually, they say, a tire will be made to last the lifetime of the car. In the meaning, when automobiles are ready to ride express highways, tires to carry them will be waiting--tires that were developed on these bady may hims.

REJUVENATION ATTEMPTS Do Not Change Length

of Life

THE length of a person s life is set by a hereditary time-clock or power of living that is in him when he is born, Prof. A J. Carlson of the University of Chicago recently told members of the American Collège of Physicians

Contrary to the pseudo-science of rejuvenation, the sex glands are apparently not one of the links that determine the life soan of the individual. They only determine the level and duration of the reproductive period of life. Man and animals, Prof. Carlson and, would still giove old, grow feelbe, and the, presumably at the time appointed by the herdinary time-clock, even if they had no infectious diseases, as the best possible diet, lived and worked under deal conditions, and did just exactly the right amount of unital and physical work.

How work may affect the life span is largely an unwritten chapter, Prof. Carlson said. No work at all seems to lead to fatness and degeneration. Excessive physical work can spparently cause degeneration by exhausting a New Section Section 2019.

BENZOATES PRESERVE FISH

DIPPING fish fillets in a very dilute and benzastes in salt brine prologs the totarge life considerably beyond that of untreated fillets. About 0.3 percent is the concentration of benzastes in the dipping solution A dip of 30 seconds to two minutes.





The miniature rubber mill, left, being used in tire development, compared with a full-size mill, right



Above: The Tell-Tale control panel and. right, the sirplane parts that are controlled from the panci

affects only the surface of the fillet and leaves on it only about 10 percent as much benzoate as that used in the preservation of apple cuder. The same treatment has proved effective with erah and lobster meat. Food laws require that fish so treated be labeled to indicate the presence of hemostres—D HK

PAINT FOR TIRES

RECOGNIZING the present upward trend of demand for white sidewall tires. The B. F. Goodrich Company announces a new thite sidewall tire paint applicable for renewing white sidewall tires or for making present black sidewalls white.

Made with a rubber base, the new paint isself vulcanizing, is clastic and thus flexes with the tire and will not crack or elip. This new type paint is applied with a brush, dries quickly and can be washed with soap and water without affecting its original whiteness.

TELL-TALE

Title new Cutties-Wright CW-20, now newring completion, should be a fine-flivered, and splendedly equipped transport of the composition of the com

A panel of lights is placed on the instrument board. These lights are electrically connected to various vital operating parts of the plane, as indicated in one of the illustrations. The warning panel itself is shown in another illustration.

If the pilot wishes to land, he simply presses one of the ten pre-selector switches eraied wind-tunnel have resulted in an airfoil and hinge arrangement for the alleron which assures ice-free operation of this vital control. The earbureter is non-ieing, and there are both pneumatic and liquid de-ieers on the wings and tail

We hope to give a fuller description of the new craft when its flight tests have been completed. Enough has been said here to indicate that our aeronautical engineers are fully alert to the need of greater safety for our arrhers -A. K.

ANNUAL REPORT OF THE N.A.C.A.

THE complete annual report of the Na tonal Advancy (ommittee for Aeronautics contains dozens of deeply technical reports, and hundreds of printed pages A summary of the guait volume is sent in advance to the Congress of the United States. It is interesting to pick out from this summary the results of the most significant research work, as an indication of the path that eventific aeronautics is following at the

A better slotted flap has become available.



marked "Land" Lights immediately show on the Tell-Tale panel to indicate what adjustiments are necessary As the landing gar is lowered, the corresponding light goes out As landing flaps and elevators are operated, their corresponding lights disappear. When the entire panel is dark, the pilot knows that it is safe to land.

that it is safe to land.

If the pre-selector switch is directed to
the right or left engine, lights immediately
appear to warn of improper operating conditions as regards fuel pressure, oil temperature, head temperature, oil pressure, and
other vital elements of engine operation
Other headings on the Tell-Tale speak for
themselves.

Internstevas.

Rende in Fall Tale, many interesting. Besides in been incorporated in the GF-20 to reduce pilot fatigns and been the possibility of accedent. Thus, large, hubbes, upokeless wheels on all instruments assure better vision of the various disla. There is a single-movement control lever for operating fleps and landing gars. Radio systems are duplicated. The landing gear restracts in five to any except of the state of

which gives such a ligh lift eapaeity that landing speed is reduced more than ever before. The new type of flap increases lift without correspondingly increasing drag. Hence there should follow not only improved landing speed, but also improvement in take-off. A "Venetian Blind" type of flap has also been investigated, but details are not yet forthcoming.

There has been much research on the "tricyele" landing gear, also known as the nosewheel landing gear. The tricyele landing
gear has been widely adopted by constructors, but has a tendency to "shimmying."
Various experiments have been made to diminish such shimmying.
Radiators for liquid-cooled engines should

Radiators for liquid-cooled engines should no longer be of the external type which produce so much drag. If the radiator is placed within a earefully designed duct in the wing, much of the drag disappears.

In the refrigerated wind tunnel it was found that iee formation on the leading edge of the wing decreased the maximum lit coefficient from 1.32 to 0.80, and increased the drag by 50 percent. This is, unfortunately, mathematical confirmation of the serious hazards of ice formation, particularly in hastening the stall of the airplane.

In its study of engines, the Committee has confirmed by tests what practical designers have long held-that the two-stroke cycle is most attractive for the aircraft Diesel .-- A. K.

MAIL BY AUTOGIRO

RUMORS have come true, and Eastern
Air Lines has received from the Kellett Autogiro Corporation a wingless 'giro which will be used by the transport company in executing its United States mail contract covering the six-mile ferry route from the Central Airport, Camden, New Jersey, to the roof of the Philadelphia general post office,

The Kellett 'giro is a one-place ship, with a large mail compartment, and will carry all the necessary instruments for blind flying and the exacting service of roof landing The new craft is a derivative of the military 'giros which have done such excellent work with the Army Air Corps. High speed will



Mail-carrying 'giro

be 125 miles an hour, with low speed less than 25 miles an hour. The 'giro will land without forward roll and take off in less than 80 yards in still air. Specifications of the ship are span, 40 feet; useful load, 620 pounds, weight empty, 1630 pounds, pay load, 150 pounds; gross weight, 2250 pounds; fuel, 30 gallons; service ceiling, 14,000 feet; cruising range, 200 miles.-- 4 K

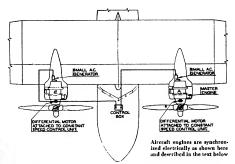
SYNCHRONIZING AIRCRAFT

ENGINES

WHEN the motors of a multi-engined airplane are out of synchronism, an annoying "beat" is produced. For example, a difference of only 20 revolutions per minute between two engines will cause a distinct "beat" every three seconds. Since it is difficult to read a tachometer to within 20 revolutions per minute, attempts by the pilot to synchronize the engines are difficult and todious. Moreover, even after the engines have been brought to the same speed by manual control, rough air or variations in operating conditions may throw them out of phase, to the renewed annoyance of the pas-

Hamilton Standard Propellers engineers have, therefore, sought to secure automatic synchronization, and have fully succeeded by a system which is both ingenious and simple in principle. When the engines are operating at approximately the same speed, the pilot merely flips a switch; the synchronizer then takes control and brings the engines to exactly the same speed and keeps them there.

A combination of mechanical and electrical principles is employed in the syn-chronizer. The actual change in speed is accomplished mechanically through adjustment of the constant-aneed control on a per-



ticular engine, by increase or decrease of the propeller pitch. But the actual adjustment of the propeller control is effected electrically and automatically by a small differential three-phase motor attached directly

to the propeller control.

The principle of operation of the differ-ential motor is that it will not rotate when the frequency of the power supplied to one of its windings is the same as the frequency supplied to the other winding Power for one winding is supplied from a small alternating-current generator driven by one engine Power to the other winding comes from another alternating-current generator driven from the "master engine". If the speed of any engine differs by as little as a single revolution per minute from the speed of the master engine, a difference of phase is created in the windings of the differential motor, and the rotor is set into motion, changing propeller pitch until all difference has disappeared

A very important feature of the differential motor is that its speed of rotation is directly proportional to the magnitude of the differences in frequency. Thus, as the engine approaches the speed of the master engine, the corrective action becomes slower Hence there is no tendency to over-shoot the mark or to produce hunting.

Manual adjustment may be obtained at any time by switching off the synchronizer, but pilots naturally prefer the automatic system of operation, and the new device has been enthusiastically received by pilots and airline operators in general .-- A K.

ANALYSIS OF LANDING

AND TAKE-OFF

N important question in transport opera-A tion is the following: "Is it or is it not safe to operate certain transport craft in and out of certain airporta?" To determine proper lengths of runways and the correct height and location of obstacles to approach or get-away, reliable information of landing and take-off characteristics under service conditions is necessary. Speaking before the Aeronautical Section of the National Safaty Council, Major A. B. McMullan, of the Civil Aeronautics Authority, described a photo-graphic system which has been developed by the Eastman Kodak Company for obtaining such vital information.

The essential equipment consists of four spring-driven motion-picture cameras with electrically operated single-frame releases. An electrical release mechanism is employed which gives absolutely correct timing. In practice, two pairs of cameras and two electrical controls are used. One pair of cameras is set on a short base of 60 feet, the other on a long base of 300 feet. With appropriate hases, markers, and so on, the airplane can be kept in view of the cameras throughout the take-off or landing process. Coordination of the films, timing devices, and so on, to-gether with a projector on which the images produced by the two cameras of a pair are projected, and which is provided with reference markers, enables complete space triangulation to be carried out A species of photographic surveying is thus accomplished The final result is that a record is obtained of the exact position of the plane in horizontal and vertical distance at any instant of time. The value of such data is obvious -A.K.

START-STOP

AMERICA operates approximately 16,000 passenger trains, and somewhere in the land a train is either starting or ending a trip

ALCOHOL HAIR TONICS PLUS MASSAGE

WHEN alcoholic preparations are used W on the scalp, vigorous brushing or massage should be used to stimulate the production of enough natural oil to offset any drying tendency they may have, according to the Journal of the American Medical As-

This statement appears in answer to a physician's query on accepted modes of treatment for falling hair.

Among the preparations suggested by the Journal for arresting acute loss of hair is a solution of cresol in alcohol. A milder form of treatment which has been the "favorite" of dermatologists for many years is a 1 percent solution of pilocarpine in 50-percent alcuhol or bay rum, according to the Journal.

"This is said to have a specific stimulating effect on the growth of hair, possibly related to its action on the vegetative nervous system."

Other formulations given by the Journal are the following chloral hydrate, from 3 to 10 percent in 50-percent alcohol or bay rum; or mercusy highloride 0.3, resortend monoacetate 6, spirit of formus acid 20, in bay rum or perfumed alcohol to make 120.

FIGURES

PUT down the figure 10, then add 88 ciphers, and you will have the amount the voice is amplified by repeaters on a telephone call between New York and San Francisco.

MACHINE TO HARVEST

SUGAR CANE

N ATIVE sugar cane conters in Hawaii will stand awestrick when the moister cane harvester shown in two of our illustrations starts golbling up stalks of cane like some starved mammoth which has chained upon a field of patietialryl juscinous grain

This gaint compare its ure 17 feet in diameter) with the truth-estarted its poinney recently to Hawaii where it will be purney recently to Hawaii where it will be purney of the purpose of the Hawaii was a superimental unit, the harvest will be "field-temporieral", any changes proved in cressry by operating trals will be made by means of the truck, shown, which is a traveling fabricating shop therefore the transfer of the truck of the truck. Shown, which is a traveling fabricating shop that with I truch Electric Company are welding equipment, driven by power take off from the truck dures shaft.

The sugar care barvester was built for the Honolulu Sugar Plantes' Assertation by R. G. LeTaminean line, and has been in process of development for many months. The idea for it give out of a discussion of care harvesting problems between Hawanan cane growns and R. G. LeTomin an

The canc harvister will cut the cane just below the surface, yet high rhough to avoid injury to the roots As it cuts the cane, the machine will pick up the stalks, take them into its cutting comparting, our them into pieces approximately a four long, then carry the pieces by convector mechanism to tracks or wagons which will travel along beside the haivester.

The engine installed in the harvester is a 160 horsepower Dresel built by Caterpillar The large generation mounted on the front of the engine is for the purpose of furnishing power to electric motars which drive the conveyors and other operating mechanism.

veyors and other operating mechanism.

This hige piece of machinery is successfully operated by only one man.

CONVERSATION TIMER

IN lineaness offices where numerous long distance calls are made in where over time is charged on local calls, it is often considered necessary to tune any given conversation carefully to avoid extra charges. In



To time talk

such offices a small clock like device called the Phone O bletty would prove mailable Operated by a clock escapement this metrmay be set for any timing up to five minutes by needy terring the dual pointer by hand Set at the beginning of a telephone conversation, it rings a hell a few seconds before the normal time is up.

PAPER GLAZE FROM CORN

THE protein from corn is being used to make a glazing or conting composition for fine printing papers. This replaces case in from milk used in similar compositions. — D. II. K.

BLIND TYPE PULL RIVET

A NEW type of rivit has been developed to be used in places where there is a hind side, that is, where one can wait from the outside wall only and where heating, lummering, or upsetting are impractinal. This new Hopkan blind rivet can be used.

for assembling the finest thicknesses of abeet metals, often where it is impossible to use other fasteners and rivers. Also, it may be used for fastening woven materials—such as upholstering to wooden or steel frames—or where it is desired to fasten boards to steel or Bakeltic.

The made part of the roset has a shank with a groose in it for pulling purposes. This is pulled through the slotted formal part. The male and founde are put through the structure from the outside with a pulling decire. C vay standard puller cam be adapted for me on the Hopkan bluid fasterier: I The pulled to its proper destination, at which in the shank of the male surpouterally and makes a smooth family, the proper detination of the same surposer of the same time the shank of the male surpostreadly and makes a smooth family, regardless of the share of the head

The rivet can be made from any type of steel, aluminium, or brass or other dinable alloy. The head can be made button, flat or hexagon, and the rivet can be made in any

CHEMICAL ELIMINATES

THE objectionable ador and type smarting which accompany interior parating instally arise from the oils which the paint contains rather than from the volatile solvents. A new product, Santomask, added to the paint, will eliminate disconfirst to the accination, the office of two temporals per gallon are most affect the normal characteristics such as driving time, durability, or color.

The manufacture, Morsanto Chennal

The manufacturer, Monsanto Chemical Company, claims that the new product will be especially advantagens for office hubbings, hospitals, whools, botchs, and homes hubbings which frequently are accupied diaing redecoation and painting

EXPLOSION DAMAGE

DANAGE from one of America's major sources of districtions dust explosion scan be materially reduced by seratching the outer surfaces of windows in factorise where dust explosions are likely to occur, according to Hylton R Brown of the U. S. Bureau of Chemistry and Smils.

Standard size panes, with a pair of diagoual scratches starting two inches from the edge and omitting a section two inches





Front and rear views of the new machine designed to harvest sugar cane

across in the center of the pane, will break at such low pressures that the exploding distawill not have a chance to knock down walls, he indicated Yet the window panes will be sufficiently strong to resist outside wind

Some such scheme is a necessary measure of "its impractical to hild walls strong enough to withstand the pressures produced," Mr Briwn pointed out. He recommended swinging sents as the most satisfactory way of getting rid of the diagerous districtly only of getting rid of the diagerous districtly beautiful or the state of the diagerous districtly only of the state of

Theored window glass, particularly of the "double-strength" A quality" most which you went in factory construction, is much too strong to went the force of an explosion successfully, he indicated. The window frame treeff may go first when such a glass is used.

Property damage in excess of \$35,000,000 and deaths in excess of 300 have been caused by dust explosions in the last two decades

Dividing a budding with inspicreed walls was another of Mr Brown's suggestions. It would prevent the spread of the explosions Explosive dusts include a with variety starch, grain, would flour, sulfur, oark and others being among them. Science Service

THAT HIGHWAY WHITE

STRIPE

SOME time ago a nationwide searth was conducted for the originance of the certainst step, by The B F Goodreth Company, and the honor was awarded to the late Advance Outer to B F Goodreth Company, and the honor was awarded to the late Advance N lines of Derind, was chairman of the Wayne County Board of Company Road to Company and the Wayne County Board of Company Search (Search Search
A plaque was presented to Mr. Hines to commentorate his great contribution to high way safety, a method now heing used internationally

His origination of the center traffic strip-

Now comes Alexander L 11 Danagh, of Chicago, who submits a photograph of a section of old highway between Mexico City and Cuernavaca, Mexico, built inder the



Traffic dividing stripe on a Mexiran road built some 400 years ago



Abore. One of the sodium bombcompared with the tube in which it will be need. Right. Final stage in the production of the hombs. Filled with triple distilled sodium, they are ready to be sealed and removed

Spanish regime 350 or 400 years ago, and charly showing that the "white stripe" was in use even then

This stone road, many sections of which are in service today, being used mainly by foot travelers and light animal-drawn vehicles, has a "built in" center line of lightcolored stones.

Mr. Durraght took the photograph at a point where the did road inter-sects the new and modern highly road for each of the "winter center line" but believes at might have been put in even in the days of comparative antiquity, to prevent quarrels between those amore in targets who wanted to be sune they got their half of the toad for that butters and warms.

SODIUM BOMBS

CETTING a pinch of sodium into the sodium vapor lamp, the golden-orange lamp which is becoming increasingly common in highway highting, is a complex problem, the solution of which involves the explosion of a "homb' smaller than a marble-

The solum lamp consists of an evacuated inbular bulb with an electrode at each end. When the current is turned on, the sodium, showing as a mitror like deposit when the bulb is cold, is vaporated and becomes the current conductor, giving the bulb is characteristic golden-orangic cold.

The problem is to get the required amount of pure sodium—about 180 ounce—mode the vacuum tube without exporting the sodium to sir. A tmy bomb, a glass built containing pure sodium, does the trick, Making the mustature bombs is a complicated process in itself. Before being seafed within the min attrace bomb, the sodium undergoes a triple distillation. Attached to the fourthwester at the containing the sodium in the sodium in the sodium in the problem of the sodium in the problem of the sodium in the sodium is released into the system to force the sodium from the needs down into the bubb. Heat



is then applied to the necks to seal off the bulbs and remove them.

After the sodium bomb has been placed in the lamp tube and the tube has been evacuated, a high frequency coil is placed around the tube. This coil induces heat in any metal within the tube, by a sort of "wireless" or radio process it causes the sodium unside to nell, to heat still further to the boiling point, and to explode its glass bond and to explode its glass bond.

The sodium is this deposited on the wallof the lamp. Its glass case is shattered by the explosion into countless pieces. Since the glass case of the loom is at the most six thousandits of an inch thick, the shattered pieces are hardly more than dust, which can be left in the lamp.

Before the miniature homb explosion method was developed in the General Electric Company's Research Laboratory, the sodium was distilled separately into each lamp.

ON MAKING FEATHER DUSTERS

This recovery and me of feathers has vast quantities of them have been diverted to warnous uns—including feather disters to warnous uns—including feather disters the strong of the stro



harder metals were tried—several types of steels, then Stellite, then Carholoy. As none was entirely satisfactory, he asked for suggestions from an ingenious worker in metals.

The successful solution was an exact reversal of the direction in which previous attempts were made. Little is known of the ultimate nature of friction, and the term "hardness" is all but meaningless without a description of the manner of its measurement or the nature of the opposing forces. Hardness as measured by penetration of a steel ball may have no relation to hardness measured by depth of groove under a diamond cutter. It is therefore difficult to predict wear or friction with unusual materials or conditions, The microscopic surface of feathers presents an unusual combination of abrasive properties of surface, composition, and shape. Rubbed against what the inventor called "hrute hardness," numute particles of metal wore away, whereas lead, not rigid, hut pliable, apparently flowed back and forth under the pressure of the feather surface Lead was proposed and pure lead rings now wear almost indefinitely -The Industrial Bulletin of Arthur D Little, Inc.

ELECTRICITY COST

THE electric current consumed during its lifetime by an ordinary 15-cent, 60-wat electric lamp costs at least ten times as much as the lamp itself. Hence, even a 1 percent increase in the efficiency of a lamp will make a sizeable difference in its ultimate cost.

PRE-CAST CONCRETE SHAPES

PITTSBURGH, the city that gave the world standardized structural steel, now has become the birthplace of standard precast concrete shapes, which simplify fire-proof construction and lower its cost through mass production.

Use of vibration, heat, and mass production methods are the three main features of the system of manufacturing Cemenstone, as the pre-cast material is known. Vibration while molding is said to produce a finer tex-

Above: Pouring the mix at one end of the continuous production Cemenatone mill. Right: A few of the pre-cast concrete shapes that can he produced with the same equipment

ture and a stronger product. Heat is used to hasten the chemical reaction of the coment when it is brought in contact with the other materials and water. It also is said to induce unform shrinkage and a product of a uniform light color. Mass production has been made possible by the development of a syrtem which permits rapid cycles of manifacture and the making of several shapes at one operation. The method of modifing curing, and aging produces elements with fultier cycles and corners so that they have the up-

Perance of cut stone
Among the products which can be pro-



Designed to speed up weeping of sidewalks and foors in industrial plants, the "Flying Duat Pan," invention of R. C. Howell, a Cleveland industrial engineer, is powered by a one-horsepower motor and mounted on General Streamline Jumbo Jr., pneumstic tires. It runs at a speed of about three miles as hour and can turn around in its own length. Picking up any type of dirt or debris, from fine duat to stones as the manipulated to work within an inch and a half of a factory will duced by this method are blocks for wall construction and channel-shaped, short-span alabs for floors and roofs, as well as longspan slabs, concrete plank, joists, brick, insulating tile, and veneering, also curbs, sidewalks, and fence posts.

The production equipment consists of a rigid steel frame over a curing chamber which produces a temperature of 160 degrees, Fahrenheit. A hopper, which fills the molds with concrete, maxed to a plastic state, rides on the top of the frame, together with withstors which agutate the mus. Steam from the curing trough keeps the molds constantly hot. After the concrete has hardened sufficient of the concrete has hardened sufficient to the concrete



ciently the products are lifted out in large groups and unloaded for aging under cover and in a constant temperature, to prevent inflavorable weather conditions from arresting the proper chemical reaction within the

COPPER CURES FUNGOUS

COPPER, passed through the skin by electric current, is being successfully used in treating fungons infections of the hands and feet by physicians at Yale University Medical School.

In the past, many remedica have been used to treat these painful and abhorrent akin infections without spectacular success. Of 37 patients treated at Yale by means of electric current, 26 have been discharged as cured. Some of them had severe infections of long duration, one for as long as 25 years. The average number of treatments given was

The afflicted person sits with his feet immerced in cannel pans and with the hands in other basins. When the infection is on the feet, the hands are immerced in all solution and the feet in 0.2 percent copper sultion and the feet in 0.2 percent copper sulting the solution. For infections of the hands the relations are reversed. The duration of the treatment is 20 minutes. Special apparatus has heen devised to obviate the danger of electric shock.

Dr. Howard W. Haggard, Dr. Maurice J. Strauss and Leon A. Greenberg described the new treatment in a preliminary report in the Journal of the American Medical Association.—Science Service.

RUBBER-TO-METAL CEMENT

There has long been need for a cement which will stick many different kinds of materials, including rubber, to metals. Such a cement has been developed by the St. Louis Rubber Cement Company and is available in all size packages from one ounce to 55 gallons. This product, which is celled Cripitic Cement, is easily applied, can be

made to be a quick or slow dryer, and to withstand any climatic conditions. The manufacturers claim that the longer it sets the more tenacious it is.

Griptite is made from a combination of rubber, selected gums, and chemicals. The result is a coment that "weldis" rubber to metal, anti-squeaks to metal, rubber to enmeded metal, felt to metal, blue wadding to inctal, cardboard to metal, and linoleium to netal and concrete.

TUBE-WALL-SCOPE AND MAGNAFLUX

TWO new procedures involving a recently developed instrument, the Tube-wall-cope, and a new application of the Magas-flux method are now being used to inspect, during production, both the interior and exterior surfaces of every length of J & L Blue Ribbon scanules set el integral joint drill pape manufactured by the Jones & Laughlin steel Copporation.

The Tubervalls-cope fills a long-fet need for an accurate, seventic method of impering the mode of military seventic method of impering the mode of inhibit goods for defecting the mode of tubular goods for defecting the mode of tubular goods for defecting the mode of the mode of tubular goods of the good of the mode of tubular goods of the good of tubular good of tubular good of tubular good of tremmer under under good of tremmer under under good of tremmer under good of tremmer tubular good of the good o



the barrel serve to center the instrument in the pipe.

As the Tube-wall-scope magnifies the size

As the Tube-wall-scope magnifies the size of the image of a defect, an experienced inspector can quickly recognize any flaw as a possible source of failure and by calibrations on the instrument barrel can then read ily determine the location of a defect. Every length of integral joint drill pipe

Every length of integral joint offill pile.

In one being produced by the company is also subjected to the Magnahitt rest. This drill pile elliniants the conventional type tool joint by having a forged upset to d joint in the forged point by having a forged upset to do joint the training the following the fol

This test consists of placing the pipe in a magnetic field and then sprinkling the pipe with a metallic powder or solution. Even though not otherwise visible, any defect will immediately become apparent as the red powder is attracted by magnetic action to a flaw and collects there.

THE KORT NOZZLE

An appendage which is in-talled perma neuly on the stern of vessels to surround the propeller as a sort of table, and called the Kort mozde, is being rapidly adopted for use on small vessels. Thus device, which a handled in this country by the Draw depending the dependent of the propeller without in the country by the Draw which is handled for use on well-designed vessels and the first which is received by the propeller without in the property designed ones. In his no moving parts, no recurrence to moving parts, consumes an overlanding the property designed ones. The story of the property designed as the hill

The duty of the Kort nozzle is to control the direction and velocity of the water pass-



llow the Kort mozele drives a sylmdrical column of water sternward, thus obtaining a "productive push"

ing to, through, and away from the propt Ber, with the further dumy of obtaining additional forward thrust through the control of the socious value of the propeller "draw" on the hydrofioli sectuoued ring. The underlying principles through which this mozile game its superior propt flung efficiency are not induje technically are too long to explain in detail here. Generally speaking, the action of the propeller is to drive stermand a cylindric cal column of water and from this propeller is accompanied.

For coast-wise and harbor towing vessels an increase of tow rope pull lietween 20 per-

Left: The Tube-wall-scope in use Below: With the Magnaflux test, invisible pape defects are detected



The Kott nozzle installed on the Dutch motorship Joma. See text

cent and 35 percent may be expected at normal towing speeds. The case of the Motor-coaster Jome of Cronnigen, Holland, will serve as an example. Trails amade in calm water over a measured mile without the Kort mozile gave a speed of 7 88 knots with the engines developing 225 5 H P at 298 revolutions per minute while the Jome was consuming 89.4 pounds of fuel per hour. After the application of a Kort nozile, on the same course and under similar sea conditions, the vessel animated as speed of 68 knots with the engines developing 219 8 11P, at 322 rouss with the engines developing 219 8 11P, at 322 rouss with the engines developing 219 8 11P, at 322 rouss with the engines developing 219 8 11P, at 322 rouss with the engines developing 219 8 11P, at 322 rouss with the engines developing 219 8 11P, at 322 rouss with the engines developing 219 8 11P, at 322 rouss with the engines developing 219 8 11P, at 322 rouss with the engines developing 219 8 12P, at 322 rouss with the engines developing 219 8 12P, at 322 rouss with the engine of the engine and the second sec

A New Joint

A NEW district withing process success fully adopted in a number of industrial plants, provides rapid, nutomatic making of welds of lowestion and medium-cardious steels, standless and other alloy steels. The "Immuned" process uses as an electrode a lare welding rod automatically fed, heared by the passage of an electrice current from it to the work being welded. The end of the electrode is constantly covered by a special granulated material which is automatically laid down in advance along the sew in to be

The granulated material used is a highresistance conductor of electricity in the molten state, and hence makes possible the use of very high current densities which cause rapid generation of intense heat. It also acts as a licat invalidor and concen-



trates the beat in a small welding zone. The molten portion floats as a longind hindred over the weld metal, protecting it from the atmosphere, and the secual welding takesplace beneath this liquid blanket, without veldence of an arx, and without sparks, spatter, smoke, or flash. By using various spatter, smoke, or flash. By using various ordinations of imperage, whose, and welding spreed, the shape and the reinforcement of the weld can be varied and the depth of the basic may be to gulared as the property of the state of the D. Luttle, Inc.

NEW LIEF PRESERVER

Title belt worn by the bathing gut in our filtustration is the invention of G. J. Peterson of North Dakota, who spent almost four years in its perfection. It inflates and quickly becomes a life preserver in an emergency. The Swimaster, as it is called, has the appearance of a handsome swimming belt, uses ordinary Sparklet sphon certridges wathable at all drug stores, and



There is nothing unusual in the appearance of the swimming belt shown at upper right, but it can be instantly inflated to act as a life preserver, as pictured above

can be used over and over again. A slight squeeze of the helt buckle inflates the Swimaster to a hooyancy more than sufficient to float the heaviest person, even in hunting elothes, from 12 to 16 hours or more, in summing position?

Munters and fishermen may wear the licht under clothing where it will remain inconspicnous and still operate efficiently

PENNIES SAVED

HOLS-WIVES labut of inflanne, the bags in which sugar, from, rec, and other smilar materials are delivered to them, has at last stumidered his makers to action A new series of printing insks to be used to print labels on such bags gives supersions which are satisfactory so long as needed, that which can be readily swaded out by the housewife By using pignent inks with these removable ones, part of the design can be removable ones, part of the design can be well leave a stam in the doth when washed out with swap and water—D. H. and water to be such as the control of the state of the s

OLD MATHEMATICAL PUZZLE STILL INTRIGUES

O NE of the great mysteries in the history of mathematics is known as Fermat's last theorem. In the year 1637, brilliant Pierre Fermat, great French mathematician,

wrote in the margin of an algebra book this statement;

"If n is a number greater than two, there are no whole numbers, a, b, and e such that a" plus b" equals c". I have found a irrily wonderful proof which this margin is too small to contain"

Unfortunately, after Fermat's death to 1665, an examination of his papers showed that he never wrote out this "wonderful" proof And it so doing Fermat left a mystery



which probably every first rate mathematician since his time has puzzled over at least

Many of Fermat's mathematical followers spent enter lews on the problem and at least three large each prizes (one in 1907 amounting to nearly \$25,000) have been offered for a solution to Fermat's moment of inceptation. Like some modern move or eigenetic contest these prizes produced a vertiable current mathematicans, and all false proofs. The present status is that the theorem has been proved for values of a less than 617.

matical Society, Dr. J. Barkley Rosser of Cornell University described a method of treating a special, simplified form of Fermat's famous theorem so that many values of n can be handled at ouce. With this method he has proved this special case for all values of n less than 8,322,403.

This special form pais on the restriction that the number is must not divide a, b, or c. Previously Dickson, in 1998, had proved this case for numbers up to 7000 and, in 1925, Beeger did it for numbers up to 19000 By comparison Dr. Rosser's contribution is enormous—Science Sertife.

ILLUMINATION

"SIGHT is precious," says the Swashington Water Power Company, Spokane, "It is estimated we use our eyes for severe visual tasks about 30 percent more than was common a generation ago—and many times more than a century ago."

FOR HOMEBUILT RADIO FACSIMILE RECEIVERS

THE amateur who likes to build his own radio receivers can now add another interesting radio development to his accounplishments. He can secure the parts and build his own facomile radio printer Because of the great unterest amoned by thilatest development in radio, The Grosleyter parts mere you hould a Radio facomileprinter which the amateur can operate in connection with his own radio receiver.

Facumile radio printing is in its infanct today just as radio itself was 20 years ago, and with the possibility of radio printing cuming into widespread use in homes and in other places as yet untouched, the radio amateur has a highly interesting field in which to carry on his experiments.



Facsimile recorder which can be constructed from an available kit of parts

The Crosley Reado radio printer is a disvolument of the Firsh nethod (See Seintife American, June, 1938) and is being need in many places throughout the country. The time probably as not far distant when radio facionile printers will consumity delorer an interesting arrain of timely newterns and pictures of new events, as well asother information, into botuse and other ularer.

CONTROL FOR PEACH

ETHYLENG debloods, workle used in formating grain, his proved more of territor in controlling peach between the true in controlling peach between many materials, now used, and in addition at is casy to apply with little diager of in many to the tree and is relatively though the controlling peach from a superior of the controlling peach from a superior manufacture, and this emission is poured about the base of the tire of the tree of any agg and can be applied at any season. In It.

SEAR OFF STEEL SURFACE DEFECTS

P (ASII) No., searing flame is removing the totileneck in the otherwise high speed, or changed production of steel from the ore pile to the warehouse of the flamshed product. That bottleneck was the stage known as bloom funsioning, when the surface defects in the steel had to be removed to ment customer.

Flaming torches, burning oxygen and acrylein gas, are now searing of the outside surface of guant liftles in many sectualls of the land. They are replacing older methods which employed many men to chip off the defects with pneumatic chiests or linge machines—power-operated but mancontrolled—which did the same thing.

Flane scarling is the name of the now inthol The steel makes have been reluctant to talk much about it until it had nethroid a success over an appreciable period of time, in full scale commercial priodiction They had been foolied, too many times below, by other methods channed to have solved the problem of bloom husbing, are replacing skeptical howeve on the faces of the nation's sixed masters.

The Lin-De-Surfacer is the name of a flame scarfing device coming into increasingly wide use in steel plants. It takes its best position in the steel mill's otherwise continuous chain of production when it is placed in the blooming mill near the guant shears that cut off chunks of steel a foot in diameter and 10 or 12 feet load.

These chunks, the blooms, go through the flame-cutting treatment, lose their surface defects and pass on to the rolling nulls.

In actual operation the bloom passes into the unit and its aurface is pre-heated, to the point where it just begins to flow, in about two seconds. This is accomplished by multiple torch openings which may number as many as 28 orifices. Then, at the proper meatant, along comes oxygen gas and sears off the outer aurface to any depth desired up to a quarter of an inch.

In the de-surfacing unit the blooms move

= cano ====

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against the blast of oxygen flame at a rate which can be as high as 175 feet a minute. The oxygen velocity is low, in contrast to the high speed flame of the ordinary oxyacetylene cutting torch, and peels off the surface. The slag formed consists of about 80 percent iron and can be used over again to charge blast furnaces.-Copyright by Science Service.

PLASTICS

N 1926, production of plastics in the United States was 10,000,000 pounds. A fast jump to 30,000,000 pounds was made by 1932, and an enormous increase to 162,000,000 pounds in 1937.

CALOMEL, VALUABLE INSECTICIDE

DOSING cabbage maggets with calomel applied in a suspension around the appared in a suspension around the young plants, as a dust, or as a coating on the seed, has distinct advantages over most other methods yet devised for combating this troublesome pest, according to Dr. Hugh Glasgow, entomologist at the N. Y. State Experiment Station at Geneva.

The insecticidal properties of calomel were discovered largely by accident a number of years ago in some tests at the Station in which all of the salts of mercury were included as a matter of routine, explains Dr. Glasgow. Such striking control of the root maggot was obtained on the calomel plat, however, that it was immediately made the subject of careful tests, with the result that it was found to have some decided advantages over corrosive sublimate, the standard treatment, although no more effective than the latter in controlling cabbage maggot.

One of the chief advantages that calomel possesses is that there is little danger of injury to tender young plants from its use, whereas corrosive sublimate must be used in a fairly dilute solution and even then may cause injury to cauliflower and radish seedlings. Corrosive sublimate is also suspected of delaying the harvesting date of early cabhave and cauliflower. Because it can be used in heavier dosages, calomel generally does not need to be applied as often as corrosive sublimate.

Calomel may be applied in suspension in water, as in the case of corrosive sublimate, or it may be used as dust, or it may be applied directly to the seed at planting time. "In fact, any method that results in placing the calomel near the point where the eggs of the insect are normally deposited should re-sult in satisfactory control of the root maggot," says Dr. Glasgow.

TONETTE: NEWEST. SIMPLEST MUSICAL INSTRUMENT

ALL his life, Zeigner Swanson liked to tink-er with flutes, to play them and to build them. It is said that flutes are as old as willow branches and a tool to cut them; and "Zig" has amassed a collection of them showing their evolution from hellow willow twigs



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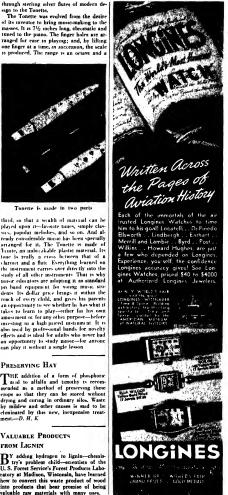
third, so that a wealth of material can be played upon it-favorite times, simple classics, popular melodies, and so on. And already considerable music has been specially arranged for it. The Tonette is made of Transection. The Tonette is made of Transec an imbreakable plastic material, its tone is really a cross between that of a clarinet and a flut. Everything learned on the instrument carries over directly into the study of all other instruments. That is why music educators are adopting it as standard pre band equipment for young music students Its dollar price brings it within the reach of every child, and gives his parents an opportunity to see whether he has what it takes to learn to play-either for his own amusement or for any other purpose-before investing in a high priced instrument It is also used by professional bands for novelty effects and is ideal for adults who never had an opportunity to study music-for anyone can play it without a single lesson

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THE addition of a form of phosphoric mended as a method of preserving these crops so that they can be stored without drying and curing in ordinary silos. Waste by mildew and other causes is said to be eliminated by this new, inexpensive treatment.—D. H. K

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One is a well-known product—methanol, or wood alcohol. Four others had not been previously discovered, although one of the group was described as theoretically possible by a German scientist. The properties of these new substances are such as to suggesther use as wood pre-cryatures, fungicides, insecticedes, adhesives, solvents, and plastic materials.

The co-discoverers, Dr. E. C. Sherrard and Dr. E. Harris, describe the first new substance as paraprophylyclolexanol, valuable as a solvent for organic gums and resins, and oils need in lacquir. It has value as a pie-creative, and its about as repellent to insects as creeoute.

The second and third substances, described as 4-propyl, 1, 2 dihydroxycy(oldex) and and 3 p hydroxycy(oldex) propanol, are thick liquids which become solid after standing a long white. Both may be made into plastic materials.

The fourth substance is crystalline and innamed, as the discoverers have not yet determined the positions of the carbon, hydrogen, and oxygen atoms of which it is composed.

Because of its complex chemical nature, ligam in its natural form has beliffed seen itself. By submitting it to the hydrogenation process, the Forest Service settinists changed its chimical nature so that it could be lanken down into component parts. The bydiogenation process already is in new comnercially in making hard fast from vegetanation grating phenomenal yields of gaodine and in getting phenomenal yields of gaodine and as good from natural perfording

In the laboratory twis the hydrogen atoms were added to a solution of puritivel lignum by means of livest and pressure and the use of a catalyst—copper chromoun oxide—another chemical indicating rapid reaction, yet taking no part in it. Under list treatment the dury, brown lignus solution changed to a links, streky, and colories fluid. The catalyst was removed by the use of a centrifuge, which winks on the principle of a certain september of the control of the contro

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Made in a variety of sizes from six pounds to 47 pounds in weight, the anchor is so designed that the 11-pound size will hold a best 38 feet in length. With the conventional type of anchor, the general rule is to allow one to Iwo pounds in anchor weight for each foot of boat length. This lightness of weight

is made possible by the design of the anchor, combined with the inherent strength of Monel

Arms of the unit are set at right angles to the stock and are equipped with a set of sharp-pointed triangular flukes. These dig deeper and deeper as the pull of the craft is increased. The broad palms of the anchor, which will bury themselves completely in bottoms of clay or sand, provide an excep-



tionally strong grip. The auchor will not dig itself out of the bottom until a direct up-ward pull is exerted on the line. Then the sharp-pointed flukes readily cut then way out.

The light weight and small size of the anchor permit case of handling and reduce the danger of damage to the hull and topsides Monel is highly resistant to corresion and the anchor will not rust in fresh or salt water.

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SCIENTISTS of the U S Bureau of Dairy making a transparent rubber-like substance from lactic acid of whey that has many promising uses in various industrial opera-

Known to chemists as polymethylacrylate, the water-white semi-solid material is closely related to the so-called organic glass made synthetically and used for highway reflectors. It is softer and more flexible than organic glass, however, but is very tough and clastic.

Laboratory results obtained by Lee T Smith and H. V Claborn, chemists in the Bureau's Division of Dairy Research Laboratories, indicate that polymethylacrylate can be produced as cheaply from lactic acid by their method as it is now produced from ethylene or alcohol by the cyanhydrin process. The Bureau scientists believe the cheapness of their process will contribute to the increased use of lactic acld.

Because of their unique properties, polyacrylates are already in demand for various purposes. Their transparency, elasticity, toughness, case of solubility, and stability to

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Unlike the related organic glass material, polymethylacrylate alone is not suitable for making molded objects, either by the compression or injection method; but it can be combined with the organic glass to make a molding material superior to any of the original compounds.

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SCIENTIFIC AMERICAN 24 West 40th Street, New York, N. Y. trode vacuum tube and the effect of a magneuc field on a stream of electrons flowing through a vacuum, the engineera have built a triode 27 inches high and seven inches in diameter. It is similar to a standard radio tube except that it has two filaments and two grids on opposite sides of the plate so that the action is visible from both directions This interesting tube is shown in one of our illustrations.

The surface of the plate is coated with fluorescent material, so that wherever elec-



The action of electrons in a vauum tube is made visihle in this demonstration model, as described

trons impinge on the plate, a green color shows. By changing the negative biasing voltage supplied to the grid, the stream of elecfrom to the plate can be varied from zero to the maximum of which the tube is capable. A pattern on the face of the plate shows the area normally bombarded by elec-

By placing a permanent magnet near the tube, the electron stream can be deflected by the magnetic field. The effect of the field on the electron stream can be seen plainly. This effect varies according to the way the magnet is applied to the tube.

The circuit used is similar to that in andio-amplifiers. A 60 cycle frequency is anplied to the grid and the tube output is connected to a loud speaker. The loudness of the audio signal corresponds to the area of the green glow on the plate of the tube.

SULFAPYRIDINE IN PNEU-MONIA CASES

ALMOST all deaths from pneumonia could now be prevented if pneumonia patients were given proper treatment on the first day they were taken sick, Dr. Perrin H. Long of Johns Hopkins School of Medicine recently told members of the American College of Physiciana. The millennium of no more pneumonia deaths, which probably could be achieved by the new chemical remedy, sulfapyridine, will probably never be reached, Dr Long said, because pneumonia patients do not see a doctor on the first day of sickness -- in fact, usually not until they are desperately sick.

Serum would not be necessary in the treatment of pneumonia, Dr. Long said, if



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RAILROADING'S LATEST CHAPTER

(Continued from page 361)

with a gear reduction unit. The furbing operates at a speed of 12,500 revolutions per munte and the diameter of the high pres sun totor is approximately 12 inches The gear reduction unit has a ratio of about 10 to 1 A main traction generator composed of two armatures mounted on a common shaft and in a common frame is connected to the turbine A three-phase alternator is mounted on the main generator shaft to supply alternating current used in the passenger car for lighting, air conditioning, and,

on some trains, part of the heating load A 50 gallon, self contained hotler of the water tube, forced circulation type and using distilled water, furnishes 45,000 pounds of steam per hour for the turbuse at 1500 pounds per square much pressure and at a temperature of 920 degrees, Fahrenben The steam is passed from a superheater through the high pressure turbine and then through the low pressure turbine. Then, justical of heing exhausted as it is on the reciprorating steam engine, it goes from the low pressure turbine to a condenser and is returned to the boiler in the form of water to be used over and over again. Only small quantities of distilled water are required to make up loss es No more than a few tankfuls would be required by the steam electric locomotive on a coast to-coast run. Compare this with the thirsty steam locomotive which may use as many as 200,000 gallons of water hauling a standard passenger train from Chicago to the Pacific Coast!

A 4000-gallon water tank of steel construction is installed in the nose of each cali of the steam-electric locomotive, this water being used for the most part in furnishing steam heat for the passenger cars

E LECTRIC energy from the turbuse gen-erators is feel to six traction motors of the axle-mounted type on each cah. Each of the motors has a nominal rating of 600 horse power. In addition to furnishing driving power for the locomotive, these traction motors have another important function. They provide electric braking essentially the same as that used for regenerative braking in the straight electric locomotive. This dynamic braking, as it is called, is used both for service stops and for controlling the speed of the train on long down-grades. On the steamelectric locomotive, it will hold the train on a 2.2 percent down-grade at any speed desired. without the application of any brake slives on either the locomotive or the train.

The motors become generators in the braking process and the power they generate is transmitted to a water-cooled resistor, a series of pipes through which water is forced to dissipate the heat generated during electric braking. The water leaves the resistor





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as a mixture of water and steam, passes into the condensers, and is returned to the con-

A 3000-gallon tank for the two-eent-per gallon fuel oil is installed near the rear of each of the cabs, next to the condensers.

An ingenious control system maintains steam flow in proportion to the load on the turbine, as well as a constant steam pressure When the engineer moves the throttle shead, the control functions to increase the amount of fuel, water, and combustion air to the boiler, and the demand for more power from the generating plant is satisfied The process is simply reversed when the engineer decelerates the locomotive. The ratio of the fuel, combustion air, and water supplied is a fixed relationship, regardless of the main power demand.

An auxiliary turbine set drives a combustion air blower, feed water pump, and fuel oil pump through gear reduction units Getting the locomotive "steamed up" prepara tory to running is a simple matter compared with the process of getting the standard steam locomotive ready for service. A small vertical fire tube boiler with a capacity of 100 pounds of steam per hour is used Pro-pane gas serves as the fuel in this boiler If steam can be secured at a roundhouse or from some other external source, the main boiler can be started without the use of this auxiliary boiler.

The running gear of each unit of the steam-electric locomotive consists of two main driving truck frames, each carrying three driving axles. The two-axle guiding trucks proted to the main truck frames complete the running goar of a 2 C-C 2 wheel arrangement.

Crew space is up front, instead of at the rear of the unit as in the reciprocating steam locomotive, and from his comfortable chair the engineer can look out over the souls nose of the steam electric lucomotive and get a clear and unabstructed view of the track ahead A defrosting system and wip ers keep the windshield clean in sleet, snow, and rain storms. The engineer operates the locomotive by manipulating two controller handles and the usual air brake system, and as a final modern touch he even has a handset telephone handy at his elbow so that he can be in instant touch with other members

of the crew What effect this new steam-electric locomotive will have on the future of American railroading, only time can decide. Among already-known advantages, the steam-electric locomotive has a thermal efficiency from fuel to the driving wheels more than double that of the conventional locomotive Its ability to travel as far as 700 miles under favorable conditions without stops for fuel or water, plus inherent high rates of acceleration and braking due to high adhesive weight, are important factors in maintaining high speed schedules on long runs. There will be say ings in brake shoes and wheels for the entire train as well as for the locomotive as a result of the electric braking. Boiler trouble should be rare, due to the use of distilled water in a closed system which climinates corrosion and boiler scale.

It is certain that the performance of the new steam-electric locomotive over the historie line between Chicago and the west coast will be watched closely, for it represents the latest manifestation of that "breeding" of inhimited possibilities to which Hora-tio Allen referred 110 years ago.



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CAMERA ADVENTURES IN WASHINGTON

THIS month we relinquish the chair to a guest conductor, no levs than Mrs (amera Angles, herself an enthiusastic fan, who describes the opportunities for picturemaking which she found on a recent visit to the Nation's Capital

Un like most natural capitals. Washington very dome ratis, photograph sally speaking Except for the Smithsonian Institute, where the picture possibilities are limited anyway, and the Senate and House agalerus, where they would be unlimited, not only are you permitted to carry your camera mit poblic buildings but the guards encourage you by pointing out interesting priture possibilities. This camera fan took pictures mostly of extensive of lindings in the amosphere of elevity and augulois trees can be taken from the windows of the Capital Capita



"Washington Sunset"

public buildings. From the top of the Washington Monument which towers over the city, you cam—if you can elbow your way successfully to the windows before other camera enthusiasts monopolize the best vantage points—get interesting bird's-eye-view whote of Washington.

Of all the buildings, the Lincoln Memorial lends itself best to picture taking because of its dominating position on the banks of the Potomac, and the wide spaces around it which permit the photographer to view it from every possible angle. Its majestic pillars cast striking shadows against the dazzing white walls. From the top stairs, frout, one gets as sweeping view of the Potomac; from the back, an interesting view of the reflecting pool extending from the Washington Monument to the Lincoln Memorial which, on a clear, windless day, mir rors both structures.

Other interesting picture possibilities are to be found in the Botanical Gardens, with its bewildering array of plants, flowers, trees, and so on, from all parts of the world, in tropical or other natural settings. You can



"Public Model"

stroll unmolested through the White House grounds (inside it is necessary to check caneras) but visitors are permitted to view only a few rooms. The White House lends itself to interesting alots both by day and by night, when it is bellikuluk illuminated.

when it is brilliantly illuminated.

If, however, you don't take to buildings,
exteriors or interiors, you can always wanlet down to the Tudal Basin—if you happen
to be in town during the cherry blossom
festival. The shot reproduced here was taken
on such a stroll when the sun was playing
hule and seek and the picture had to be
focused in advance and mapped the
moment the sun came out of hiding. You can
walk clear around the basin along a path
which hugs the water's edge for the view
from the water's edge does not intrigue you
sufficiently, you can hure a boat and try your

luck from the water

The Tidal Basin always attracts a good crowd and something interesting is bound to happen. The picture of "Daniel Boone" was taken the first day your photographer arrived in Washinston. "Daniel Boone."

spotting our camera, greeted us with a hearty smile and an even heartier offer to at a price. A little nonplussed, we corned his offer until a more charitable photographer of the male sex took him up on it. To express his appreciation, Daniel showed the young man, and an ever increasing throng which crowded around him, pictures which had been taken of Daniel in a Russian costume by a dentist photographer in the U. S. Navy. He also showed us pictures in which he appeared with Hedy



"At the Concert"

Lamarr in connection with one of her recent

Relenting, we accepted his offer but had considerable difficulty in getting him away from the crowds as well as inducing him to avoid posing. As his photographic income soared, he became even more loquacious. He is apparently a well known character and takes parts in historical pageants, fairs, and so on. Two young ladies from Philadelphia identified him as having ridden in a historic carriage during a celebration there. To us, Daniel confided boastingly that he expected to be at the World's Fair with Ford or some other exhibit. All the while, he never for a moment lost sight of prospective photographic victims. If an uncharitable photographer tried to shoot without paying, Daniel would pursue him, with the crowd after him, crying out that this was money he needed for food and lodging. When we finally parted, we gave him the address of Mr. Camera Angles in the event that he does turn up for the World's Fair.

Just before leaving the scene of this adventure, we could not resist taking a shot at the sunset on the waters which, though ordinarily like a mirror, had been made turbulent by a strong wind. Fortunately, we had remembered to bring a lens shade, for without it, this picture would not have been attempted.

On our last day in Washington, Marian Anderson was singing before a record crowd at the Lincoln Memorial. Because one of the guards had said he would be "shot" if we tried to slip under the ropes which held back the throngs, we had to content ourselves with leaning over the ropes and shooting from that vantage point.

The camera made many new friends for us. We found this time, as we had on so many previous occasions, that not the least of the



values of sightseeing with a camera are the exetting adventures to which picture taking invariably leads

CAMERAS AT THE WORLD'S

FAIR

WE have it on the word of the officials of the New York World's Fair that pho tography by amateurs will be freely permitted and, in fact, encouraged The only re strictions on this score are that professionals will be barred since the professional conces sion at the Fair has been awarded to Underwood & Underwood. Incidentally, the Eastman Kodak Company will do its own large bit by sponsoring photographic exhibitions by various organizations and by helping amateurs in their exposure and other photographic problems at the Fair. One of these helps will consist of specially built backgrounds against which the amateur may photograph his best girl, and vice versa

PRESS CARDS

THE notion seems to have gone abroad that a press card is something that may be purchased and automatically will admit the holder to all functions. The only press card of any value is one issued by the Police Department of the particular city in which pictures are to be made, and money will not buy 11. It is issued only to accredited working press photographers associated with specific newspapers. In New York City, the press cards are distributed by a central news reau, to which the cards are entrusted by the Police Department, and are issued for three months at a time

PRINT THROUGH THE BACK

F your negative looks too sharp for the picture's good, you may find the solution in projecting your negative through the back of the printing paper rather than by the normal procedure of directly onto the emulsion. The negative is reversed in the holder-that is, with the emulsion side facing the lamp rather than the lens—and the paper is turned upside down. If your easel has any metal or



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other bright parts built into it, cover the easel with an ordinary sheet of paper and then place the printing paper, face down, on top of it Either single weight or double weight paper may be used, the double weight nation rally requiring a longer exposure than that needed for the single weight

NEW PHOTOGRAPHIC TERM

THE ever-widening use of exposure meters of all types has recently brought into sogue a brand new photographic term de scribing the act of using a meter to "read exposure The term is "expometering and is introduced by Joseph M. Bing, FRPS It seems that photography is destined to make its influence felt in the dictionary as well as the many helds at already touches

"DESIGN IN SUGAR CUBES"

TWO separate exposures of a simple setin mind than to give one a little more time than the other, provided the inspiration for the combination of the two negatives reproduced here Accidentally, one day, the two

Sturt of an inspiration ...

negatives being enclosed in the same glassine pocket, we looked at the negatives against a light and saw what we thought was an unfamiliar negative Actually, the two negatives were so positioned that they provided a strange pattern very much resembling a caricature of a human figure. So the two were placed in the cularger as they were, with the emulsion side of one facing the easel and the emulsion side of the other facing the light A rather long exposure was required,



... and what resulted

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for one reason because two negative densities were being exposed, for another because of the overall density of the individual nega-tives. Had the job been done according to a pre-conceived plan, a darker background would have been employed in order to provide greater transparency, although in that case the shadow effects would have been less pronounced.

"KITTEN ON THE WINDOW SILL"

EVERY morning, some time before eleven, this white kitten sits on the window sill of the apartment just below ours, bathes itself in the sun and surveys the world below it. Our appearance at the window above at tracts her attention and she watches us through one of the window panes, partien larly attentively if we happen to have a camera in hand. One such morning, it occurred to us to expose a negative to this matutinal habit and the picture you see is the result



Kitten on the Window Sill'

In making the enlargement we hard up the edge of the wall with the long side of the print in order to overcome the tilt in the camera position necessitated by the subject The angle is, however, identified by the diagonal lines of the upper and lower parts of the window as well as the diagonal lines of

"Corridor Ceiling

LICHT"

THE opportunities for pictures that he even in humdrum subjects is illustrated by this shot of the interesting pattern sur-rounding a small ceiling light. Waiting for the elevator sometimes has its advantages, for it was on one such occasion that we happened to be studying the coiling-for lack of something better to do-and, noticing the practically symmetrical arrangement of the pattern "leaves" all around the lamp, thought of the camera hanging idly from the shoulder. It required a low, crouching position and a straining of the neck, the camera being of the range-finder type, to get into as central a position as possible under the circumstances, short of lying on the floor. At the full



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Specific rules for this contest were published in our May number. Be sure to read them before you submit prints.

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Division 2 Lands: apes -including all scenic views, close-ups of parts of landscapes, sesscapes, and so

Division 3. Action—including a types of photography in which ac-tion is the predominating feature In each division there will be prizes of two Longines watches—The World's Vost Honored Watch—and two Fed-eral Enlarger, as well as five Honor able Mention (wards

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chromatic film, we made three shots, at 1/10, 1/25, and 1/50 of a second. Although we knew we could not fail to record the light, our chief concern was with the shadows which were projected upon a relatively dark ceiling. Also, because we were shooting directly into a light source, we expected flare



"Corridor Ceiling Light"

and were not sure just where this would strike the film. In one of them, luckily, the flare struck just outside the ring of shadows and we were able to make a print by excluding this flare spot through appropriate cropping. The square composition was inevitable because of the nature of the subject.

PHOTOGRAPHIC EUROPEAN Tour

THE picture train idea, started some time ago, has now risen to greater heights to assume the ambittous proportions of a First Annual Photographers' Grand Tour of Eu-Annual Photographers Grand Iour of Eu-rope. Organized by the Walker Travel Agen-cy, of Ridgewood, New Jersey, this first Eu-ropean photographic tour, by private motor coach, is to have as its photographic leader and mentor, the well-known pictorialist, Edward A. Alenius, F.R P.S., who will be the lecturer, advisor, and consultant on all phases of photography

The tour will begin on August 11 and will last through September 25, during which period the following countries will be visited: England, Holland, Belgium, Switzerland, Germany, Italy, and France.

ANNUAL LEICA EXHIBITION

THE annual assembly of the course of photographs made during the course of under way. Leica users are the year is now under way. Leica users are advised that no specific restrictions are placed on the choice of subject matter, which may be a portrait, an aerial, candid, action, medical, animal, insect, or any other type of picture. Actual color prints made from Leica color transparencies are also invited, as well as sequence pictures.

The rules announced for submitting prints to this, the Fifth Annual Leica Exhibition, are as follows: There is no limit placed on the number of prints that may be submitted; prints should not be less than 8 by 10 inches in size; prints may be submitted mounted or unmounted, but if mounted, the mounts should be of a light color and conform to the standard sizes; on the back of each print or

mount, the photographer should include his name and address; the lens used; shutter speed and disphragm opening; film used, developer for the film; filter, if any, as well as other accessories used to make the picture: and, if possible, the name of the paper ture; and, it possible, the name of the paper and the developer used to make the prints. Contact prints should accompany photographs but should not be pasted on the mounts; all packages should be addressed to E. Leitz, Inc., 720 Fifth Avenue, New York, N. X., and should hear the word EXHIBIT in the lower left corner.

SHOOTING IN THE BACK

OCCASIONALLY you run across a sub ject, such as a broomstick vendor, with brooms of various descriptions jutting out from under his arms and over his shoulders, which presents an opportunity for a shot in the back. These persons are usually on the go so it will be necessary to follow the subject and shoot as best you may. A good way to keep him in focus is to set your camera for a given distance, walk briskly or slowly, as the case may be, until you reach this distance between camera and subject and let the latter's walking speed pace your steps.
When the moment seems ripe, shoot quickly and use a relatively fast shutter speed as a precaution against camera unsteadiness at the moment of exposure.

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PIERCE EXPOSURE METER (\$1.85): Optical type meter. Entirely pre-settable, no calculations required. Film speed and filter factor, once having been set, need not be changed until filter or film is changed. Each meter complete with neck cord and packed in individual box complete with instructions for operation and listing in Weston system of 79 different emulsions. Two models available, for motion picture and still cameras.

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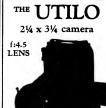
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action, the square format Exakta has automatic film transport of same order as incorporated in Kine Exakta; that is, one movement of lever winds film to next exposure, at same time winding shutter and dropping mirror into position

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Amateur Photographers

New Ways in Photocalarty, by Jamb Baschia, Eminently practical Jamb revery point of view, this new book contains nothing of theory and nothing that the advanced amateur photographer will not find valuable in one way or another. It covers the discussing such things as trick photography, photomurals, retouching, infra-red, and a number of other ambdivisions that will not be found elsewhere in as clear and conclea aman-

INFRA-RED PHOTOGRAPHY, by S. O. Rawlings. A treatise on the use of photographic plates and films sensitive to infra-red. Exposure and processing are fully covered; formulas are given for sensitizing, \$1.65.

UNIVERSAL PHOTO ALMANAC AND MARKET GUIDE. How, when and what to photograph in order to make money with your camera; where to sell different types of prints, \$1.00.

CAMERA LENSES, by Arthur W. Lockett. Explains simply and clearly, yet with scientific accuracy, all the underlying principles of lenses. \$1.10.

CHAMPLIN ON FINE GRAIN, by Harry Champlin. A complete hand-book on the entire subject of fine grain, including formulas and how to compound and nee them. \$1.90.

PHOTOGRAPHIC HINTS AND GADGETS, by Fraprie and Jordan. How to make all kinds of photographic accessories; from film claps to cameras to lighting equipment, and so on; 250 articles and nearly 500 illustrations. \$3.70.

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Q. Occasionally, in exhibition prints, I notice a fine lustre which appears to be a surface treatment. Can you tell me how this is done?—C. L.

A. Mix equal parts of olive oil and turpentine and apply evenly over the surface with a wad of coliton, following this by poltching with a soft cloth. Another popular formula includes.

Pour a little of the solution on the print and then rub in with cotton. When the entire print has been treated in this way, polish dry with a soft cloth or a fresh pad of dry cotton

Q. Not being too familiar with the various makes of photographic lenves, I am at a loss in making a selection. I am at a loss in making a selection. I am to the property of a winders 21½ by 2½ reflex type camera. Which would be the more desirable, one equipped with a Rodenateck Trinar to 1/300th or one having a Heliar //3.5 lenv in a Compur Rapid shutter, I second to 1/300th ~ J. K. 1 second

A. For all practical purposes, one lens will give a good a performance as the other Your choice, therefore, must be on the abase of the other factors involved, the higher lens speed of the f/20 over the f/35, which is negligible, and the difference in the top shutter speeds. It would seem that the choice would depend cheefy on the design of the camera. Basically, they are the same, of course, but there are other factors which, in a personal estimate, would place one camera above the other.

Q. Can you cite me references to information on the hypersensitization of film by mercury vapor? Also on the subject of photography by Infra-red light? —J. A. M.

A. The method of dry hypersensitizing with mercury vapor is fully described by the discoverers, Dr. F. Dersch and Dr. H. Luerr, of the Agía Ansco Research Laboratories, in the report of their experiments printed in the Journal of the Society of Motion Picspie Englishers (Vol. XXVIII, No. 2).

We believe that you may be able to obtain a reprint of this report by writing to the Agfa Ansoc Sompany at Binghamton, Newberling to the Agfa Ansoc Sompany at Binghamton, Newberling to the Agrant of
Q. At what aperture does my //2.8 lens reach its maximum resolving power?—D. G. L.

A Generally, this occurs at the stop [7:56], that is, is, to stops smaller than the maximum specture of your lens. For this reason, if perfect sharpness is what you want, you would do hest to try to work at this apertitum whenever possible Of source, shopping down will give you greater depth of field, in which case you will be willing to secretice the self-section of the state of the section o

Q. Is there any means of achieving an //64 aperture on my three-inch lens by means of a sort of Waterhouse stop?

—A. I. W.

A. The stop / 22 as the smallest that has been found practical with lenses of this short local length, but the great depth of these miniature lenses as compared with those on the larger cameras more than makes up for this lamination as to disphragm stops. The reason that extremely small always used as //54, cannot be obtained with the miniature daphragmas in at the diffraction of light at these small operatings would be too great and the standard of the second control
Q. My camera case has been used so long that it could at and a little reconditioning. What is a good polisher for this purpose?—D. K.

A. Propert's Saddle Soap is a standby with many. An excellent formula that you can make up yourself and rub into the leather with a soft rag consists of 50 parts lanolin, 40 parts castor oil, and 5 parts each of sodium steraste and japan wax.



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TO Nature (London), in which scientists regularly report progress in their work for the information of other professional scientists, Dr. Walter S. Adams, Director of the Mt. Wilson Observatory, has given the account of work preliminary to final figuring of the 200" mirror which follows.

The present figure of the 200" mirror approximates closely that of a sphere with a radius of curvature of 111 feet. The disk was first shaped on front, back, and edges by grinding with coarse Carborundum and the center was then hollowed out to a depth of about 3%," with the aid, first of a 50" tool, and then of successively larger tools up to the full size of 200". As the spherical figure was approached, finer grades of Carborundum were used, so that when optical tests became necessary only a few hours of polishing were needed to give the surface sufficient reflecting power. During the first stages of work upon the disk, the cylindrical holes on the back of the mirror and the large areas between the supporting ribs were filled with plaster of Paris, and after the face and back had been made parallel the 40" opening at the center of the disk was closed with a glass plug weighing about one ton. The plaster of Paris was removed when the surface had reached nearly the required form, and the mirror was placed upon rubber pads which rest on the frame of the support system of multiple counterweighted levers. The friction of these pads was required to neutralize the strong lateral pull of the grinding and polishing tools making contact over so large a surface, and for this reason the horizontal plates of the supporting system were not engaged. The optical tests, however, were made with the mirror vertical and balanced upon the support system just as it will be wh in use on the telescope. Future optical work, including the parabolizing, will be carried on with the intrror resting upon the rubber pads; but these will be removed when the

figuring is completed
"From the first the optical tests of the
mirror proved to be most satisfactory No

change was seen in the figure when the mirror was tipped repeatedly from a horizontal to a vertical position or when it was rotated. Also no local deformations could be detected at the points of contact of the 36 individual lever supports. In fact, the support system was found to be performing quite as well as had been boped by its designers. The length of the radius of curvature proved to be about 2" less than had originally been planned, but this slight difference, amounting to about I" in the focal length, is far within the limits allowed for in the design of the telescope, and it is probable that no attempt will be made to reduce the amount through polishing. The surface was found to be reasonably free from zones, hut a small amount of astigmatism was preent amounting to about 0.1" in the optical cut-off at the center of curvature. This proved to be due to a slight deformation of the disk caused by the horizontal pads upon which the mirror rests. [Supplementary note added in letter from Dr. Adams to Scientific American, to bring article up to a later date: "Through suitable changes in the supporting pads this astigmatism has now (March 15) been eliminated by a small amount of fine grinding and polishing. The zones have also been considerably reduced and the entire mirror surface is nearing an accurate spherical figure. Work will soon be commenced upon the final figuring of the 120" plane mirror to be used in testing the parabolization of the 200" surface."]

"Although the final parabolic curve of the surface of the mirror will be only 0.055" deeper than the spheroal curve, the area is o great and the process of polishing so slow that it is planned to make most of the change through fine grinding and to leave but the final stages of the figuring to the polishing tool. This procedure has already been found successful in figuring the spherocal curve.

"Accurate tests of the parabolic figure of the 200" mirror will require the use, as an auxiliary plane, of the 120" mirror. The com-

pletion of this mirror will be one of the next major undertakings in the optical shop. It is at present shaped on front, back, and edges, and the surface has been ground approximately flat. It is planned to figure the three auxiliary hyperbolic mirrors, one for the Cassegramian and two for the coudé com-bination, by the method devised by Hindle, without the use of the 200" mirror, Four spherical mirrors, each about 40" in diameter and with a radius of curvature of 25', are being prepared for this purpose, two being very nearly completed. The mirrors will be used side by side in a cloverleaf pattern and provided with adjustments for bringing their centers of curvature into accurate coincidence.

A few figures are of interest as inducating the scale of the optical work on the 200° mirror. About five tons of glave have been removed in the process of slaping and figuring, and about 20 tons of Carbornadium laws been used for grading. During the polyshing, about 50 pounds of rouge as hour is the warage consumption with the full said tool, and but a small fraction of this material can be salvaged. As a result, rouge has been purchased in quantities hitherto quite under the purchased the purchased in quantities hitherto quite under the purchased the purc

F you can train your eyes to perform sunably, you can superpose the two images shown in Figure 1 and obtain a three-dimensonal view of the 200° mirror and of the lettered image. You are standing in the lolly stuster's gallery in the Opical Shop at the California Institute of Technology, in Pausciae, California Institute of Technology, in Pausroux, California, looking through the winches, California, looking through the wineless, California, Indiana, and the contraction of the control of the conputer view of the company of the control of the

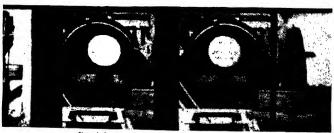


Figure 1: Stereoscopic views of the 200" telescope and reflected image

approximate eye level and 2' or so in front of the window. In Russell Porter's words, "you'd swear the image was material. Startling!" It seems to hang in space and you feel the urge to feel of it, others comment.

Thus far, however, there is nothing stereoscopic about it; in fact, the stereoscopic part has no connection with the apparatus or mirror but was obtained by taking two pholographs from the visitor's gallery, the second one made with the camera shifted sidewise about the same distance as the separation of the average man's eyes. These photographs were taken by David O. Woodbury, an amateur telescope maker who, after spending several months in Pasadena and Mi Palomar, has written a book about the 200" telescope, one chapter of which was recently pre-published as an article in Reader's Di-(the entire book is due to appear in October)

There are three ways to get the threedimensional effect (1) use a mounted pair of primanic lenses; (2) hold a long strp of cardboard between the end of your nose and the center of the pair of pictures, so that the right eye sees the right-hand picture alone and the left eye the left-hand picture alone, and then try to drift off into a focus on infairly think dreamily about that brunettel, or (3) command your eyes to do the Irick without any cardboard—this can

he done hy many, after a bit of practice.

The square object in the immediate fore-ground is a rack to carry the kinte-edge, when the purpor is tested à le Foucault.

RELENTLY, in one of the innumerable newspaper tiens which describe a mirror as a "lens," your sorhe was further enablement by the statement that a "lens' had been "pobleded with face powders" in a difficult to figure out how this howlet only difficult to figure out how this howlet original to the statement that the property of the p

ANNOUNCEMENTS: Stellafane convention will be held on Saturday, July 22— R. J. Lyon, Secretary, Springfield Telescope Makers, 252 Summer St., Springfield, Vermont.

ARL GROSSWENDT, 31 W. 87th St. New York, Secretary of the Optical Division of the Amaleur Astronomers Association, New York City, states that the Optical Division (which is simply the for mer New York Telescope Makers) cordially invites all amateurs who visit the New York World's Fair to inspect its workshop deep in the howels of the earth under the Hayden Planetarium, at 81st St. and Central Park West. It asks that, if convenient, such visitors first notify the Optical Division by telephoning as follows: Mon., Thes., Wed., Thurs., Fri., 10 to 4, ENdicott 2-8500, Ext. 478: 6 to 9. Ext. 509. Sat and Sun. 2 to 9, Ext 509. Even if you lack opportunity to make such arrangement, the planetarium guard may by luck find someone in the optical workshop. Planetarium performances, which you may wish to combine with this visit, take place weekdays at 2:00, 3:30, 8:30. Saturdays at 11:00, 1.00, 2:00, 3:00, 4:00, 5:00, 8:30. Sundays and holidays at 2.00, 3:00, 4:00, 5:00, 8:30. An exhibition of products of amateur assera' activities will be held in an ad-

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THE BEGINNER'S CORNER

ROSPECTIVE beginners at telescope making very frequently have attacks of deep-dved doubt regarding their ability to make a telescope, and to these we commend the two photographs reproduced here, showing telescopes made respectively by an 11year-old lad and a lady. Not that telescope making is a juvenile or feminine hobbyin most cases it pretty definitely isn't. Simply, these telescope makers are beyond average in ability, for age and sex, but not men. Donald Bird is the youth and Wallace (



Donald Bird and his telescope

Swank science teacher at the Eaton Rapuls Public Schools, Eaton Rapids, Mich, sends us up account of his success, stating that Donald was 11 years old when he finished this telescope Some of your readers may think," he continues, "that Donald did perhaps a little of the work and an older person most of it, but such is not the case, he did it all His mirror is 414" in diameter with focal length 34", and is mounted in an octagenal tube of plywood He used pipe fittings for the mounting" to far as the conductor of this department can recall. Donald Bird is the youngest lad to have made so creditable a telescope. Natural mechanic.

The lady in the other photograph is Mrs. Albert M. Bonelli, 2515 Drummond St., Vicksburg, Miss, and she states that "the



Mis. Bonelli and her reflector

in Scientific American that it wasn't impossible for me to do what others had done, and that I might realize a life's ambition liv making and owning a telescope 50 I obtained a kit of materials, your instruction book 'Amateur Telescope Making,' and got husy This 6" reflector was the outcome, after 72 total hours of hard work

In difficulty the amateur telescoptical hobhy starts at the level of work such as these examples and may be made to extend just as far as the follower cares to extend it toword and into really advanced work

ROM a very old hand at the telescope making hobby, Harold A lower, of San Diego, we receive the following comment: "Here is something I think you ought to bear down on, in your Beginner's Corner—the chapter in 'Amateur Telescope Making' on roual testing. I have found that there are a surprising number of amateurs, some of whom have made several mirrors, who don't even know that chapter is in the book. Lots of them think all they need to do is use a Ronchi grating, and polish until they get curved lines. Naturally, the result is usually a deep hyperbola. Honestly, I think there would be more good mirrors if the Ronchi test had never been heard of. It is useful, of course, but most beginners depend on it too much

The chapter on zonal testing extends from page 96 to page 100 of "ATM".

TELESCOPTICS

(Continued from preceding page)

inclusive, and a convention of amateur a tronomers will be held on August 19 and 20 tronomers will be near on August 17 and a Lin "Amateur Telescope Making "Advanced," the sequel book to "Amateur Telescope Making," H. E. Dall describes the camera obscura, which is essentially a refracting telescope for use from indoors. The first since then to make one is William R. Crosby, 566 Glide St., Rochester, N. Y., a member of the thriving group of amateurs in that city Figures 2, 3 and 4 show the design and construction. At the top, in Figure 2, is an elevation showing a roof and, pro jecting above it, a flat both prvoted and rotatable. This picks up rays from any chosen object and directs them downward through the objective lens shown, which projects an image on a horizontal viewing table several feet beneath. Here the image may be viewed with the eye or, if still higher magnification is desired, with a microscope called a viewing telescope. The lower elevation shows the apparatus from another quarter.

Crosby, however, did not build his camera obscura into his house but into his autom bile trailer. Figure 2, taken outside, shows the trailer roof and the raised flat, while Fig-



Figure 2: Roof, flat, and its hat

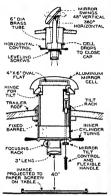


Figure 3: Front and side views



Figure 4: The inside end of it

ure 4 shows the interior part of the instru-ment, also the interior of the trailer (this Crosby also built).

Your scribe has sat in this trailer, rotated the flat and examined the landscape roundabout, and can testify that the spectacle came far above best expectations. Because the observer sits in the dark, his eye is not skyflooded. Therefore the large image on the table appears to be vividly colored—even more vividly than the actual landscape. A long, continuous panorama of greens and sky-blues aweeps across the viewing table, which in this case is the dining table of the which in this case is the dining table of the trailer, and several persons can examine it at one time. For astronomical work the cam-era obscura equates with a refractor of the enclosed observing room type.

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LEGAL HIGH-LIGHTS

Patent, Trade Mark, and Related Legal Proceedings That May Have a Direct Effect on Your Business

By ORSON D. MUNN, Litt.B., LL.B., Sc.D.

New York Bar Editor, Scientific American

FAIR NEWS

THE New York World's Fair Corporation has recently restrained a publisher from using the title "Illustrated Fair News' in connection with a magazine relating to the New York World's Fair. The publisher originally published a magazine entitled "World's Fair News" and the New York World's Fair Corporation obtained an in junction restraining him from publishing a magazine under that name. Shortly after the original injunction was issued, the defendant indicated his intention of using the name "Illustrated Fair News" in conthe magazine and the New York World's Fair Corporation made an application to have its injunction extended so as to restrain the new name. The Court extended the injunction and restrained the use of the new name on the grounds that the publication "was ob yously designed for the purpose of enabling them to continue their exploitation for business purposes of the possibilities arising out of the World's Fair

EXPERIMENTATION

PATENT for a process must fully de-A serihe the process so that it can be carried out by the proverbial "man skilled in the art" without the necessity of any further experimentation, If further experimen tation is necessary to carry out the process. the patent is invalid for the reason that it is indefinite and does not fully disclose the invention

This principle is exemplified by a recent suit for patent infringement which involved a patent for a process for propagating yeas in which the production of alcohol is reduced to a minimum. In describing the process the patent suggests that seed yeast be placed in a wort having a specific gravity of one degree Balling After the process of reproduction is initiated, concentrated wort having a specific gravity of approximately 12 degrees Balling is slowly and substantially continuously added to the original wort over a protracted period of time. The patent states that the concentrated wort should be added "at a rate such that not only the alcohol which may have been formed from the quantity of sugar present in the diluted portion of the wort, but also any alcohol which may be formed from the sugar which is present in the added wort, can be assimilated imme-

diately by the yeast." The Court held that further experimentation was necessary in order to ascertain the times and manner in which the concentrated wort should be added. For this reason the Court held that the patent was indefinite, did not fully disclose the invention, and accordingly was invalid. In reaching this conclusion the Court made the following

"But even if the process disclosed by Hayduck be held to constitute invention, the patent is invalid for indefiniteness as was held by the learned District Judge Both the times and manuer in which the concentrated nutrient solution is to be added may be ascertained, as we have stated, solely by ex perimentation. The disclosure of the patent is therefore too vague and indefinite to con stitute invention "

DOUBT

IT is an established principle of patent law that in connection with the prosecunon of patent applications all doubts with regard to the question of invention must be solved in favor of the applicant Thus in a case where doubt existed as to whether the advance made by the applicant for a patent rose to the dignity of invention or merely amounted to mechanical skill, the doubt should be resolved in favor of the applicant and accordingly a patent should be

In a recent case involving an application for a patent on a method of making artificial sausage casings the Examiner had originally held that two of the claims were patentable Thereafter the Examiner reversed his decision and held that the claims in question were not patentable. On appeal to the Court of Customs and Patent Appeals it was con tended by the applicant that the Examiner's action in originally allowing the claims, and then rejecting them, indicated that there was some doubt on the question of invention It was argued that in accordance with th principle set forth above the doubt should he resolved in favor of the applicant and the claims should be allowed. The Court of Customs and Patent Appeals rejected this contention and held that the merc fact that the Examiner had reversed himself did not indicate that there was doubt on the ques tion of invention.

BREATHING

THE word "breathing" as applied to tex tile fabrics was held to be descriptive by the Court of Customs and Patent Appeals and accordingly not registerable under the Federal Trade Mark Act of 1905.

A textile manufacturer attempted to regster the words "Breatling Back" as a trade mark for pile fahries having an adhesive coating on the back thereof which was impervious to water but pervious to gases and air. The registration of the mark was opposed by a competitor of the manufacturer on the grounds that the words "Breathing Back" were merely descriptive of the characteristics of the pile fabric. The Court found that the word "breathing" had been used for many years to describe artificial leather and certain fabrics which were perreasing and certain tables which were per-tions to gases and air. It was accordingly concluded by the Court that the words "Breathing Back" were merely descriptive of the pervious characteristic of the pile fabric and under the circumstances the words could not be registered as a trade mark. In rendering its opinion the Court stated as follows:

"We are of the opinion that 'Breathing Back' as applied to applicant's goods does nothing more than to describe the character of the back of applicant's pile fabric which, by reason of its porosity, permits breathing or passage of the air through the back."

ANTENNA

IN a recent case of importance to the radio eommunications andustry the United States Supreme Court held that a patent on a directional antenna was not infringed hy autennas employed by one of the large 1adio communications companies

The Court found that the patent in suit related to a V-shaped wire antenna based on the so-ealled "Abraham formula," which provides that when radio activity is projected from a charged wire having a length which is a multiple of one half the length of the waves projected by the antenna, the angle of the principal radio activity is a function of two variables, namely, the wavelength and the number of half wavelengths contained in the wire. The patent in suit set forth an empirical formula based on the "Abraham formula" for determining the most efficient angle for disposing the wires in a V-shaped directional radio antenna. The Court found that the patent, being based on the "Abraham formula," was strictly limited to an antenna in which the length of the wire was a multiple of onehalf wavelengths. All of the antennas employed by the defendant, with the exception of one, were found to have a length which was a multiple of one-quarter wavelengths but not of one-half wavelengths. These antonnas were held not to come within the "Abraham formula" and not to infringe the patent.

The remaining autenna which had a length which was a multiple of one-half wavelengths was found to be disposed at an angle smaller than that prescribed by the formula set forth in the patent in suit and it was held not to he an infringement

SPACHETTI

MANY spaghetti caters will no doubt be annoyed by allegations of the Federal Trade Commission that the authenneity of spagheth is not determined by the length thereof. In a recent proceedings insututed by the Federal Trade Commission against a manufacturer of spaghetti and macaroni it was charged that the manufacturer was guilty of unfair methods of competition because his advertising matter stated that macaroni and spaghetii not made in long lengths was not genuine. The Commission charged that these statements were false, deceptive, and misleading and the manufacturer was ordered to show cause why he should not cease and desist from making further representations of this character,

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ALBERT A HOPKINS A P PRIK PROFESSOR BENRY NORMS RUSSELL. ALBERT G INGALLS
A M TILNEY
PROPESSOR ALEXANDER ALEMIN F B MeHPGH CONTRIBUTING EDITORS

A. I. BI'(BANAN, Jr. Director of Besearch, Rentington Arins Company I, WARBINGTON CHIEBS Director of Revert In Jaboratories, Westinghouse Electric and Manu-facturing Company facturing ('s

IACOB DESCRIN, Ameteur Photography CHI BCHILL EISENMART, Department of Mathematics, University of Wisconsin Stallsdelan, Wisconsin Agricultural Station

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M LICKESH Director, Lighting Research
Laboratory Insendencent Lainn Dept. of Gen
ceal Electric Company, Nels Park, (Cereland
I T Macilol'GAL Associate in Fign. Biology
Caracgel enstitution of Weshington.

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History

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For MEN

who want to become independent in the NEXT TEN YEARS

IN the Spring of 1949 two business men will be sitting in a mid-town restaurant. "I wonder what's going to happen next year," one of them will say. "My business is fine now—but the next few years are going to be hard ones, and we may as well face the facts."

The man across the table will laugh.

"That's just what they said back in 1939," he will answer. "Remember? People were looking ahead apprehensively—and see what happened! Since then there habeen the greatest growth in our history—more business done, more fortunes made, than ever before. They've certainly been good years for me."

He will lean back in his chair with the easy confidence and poise that are the hall-mark of real prosperity.

The older man will sit quiet a moment and then in a tone of infinite pathos:

"I wish I had those ten years back," he will say.

• Today the interview quoted above is pinely imagmay. But be assured of this—it will come true. Right now, at this very hour, the bisiness men of America are dividing themselves into two groups, represented by the two individuals whose words are quoted. A few years from now there will be ten thousand such luncheons and one of the men will say

"Twe got what I wanted."

And the other will answer.

"I wish I had those years back."
In which class are you putting yourself? The real difference between the two classes is this—one class of men hope vaguely to be independent concetme, the other class have convinced themselves

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SCIENTIFIC AMERICAN



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NINETY-FIFTH YEAR • ORSON D. MUNN, Editor

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The Great American Rite-By T. Swann Harding

The Public is Largely to Bleme for the Too Casual and Rou-

THE most intrinste part of a television receiving set is the rathode-ray tube, described in some detail on page 23 of this issue and illustrated during one process of manufacture on our front cover. Here the operator, a skilled glass worker, is sealing into the narrow neck of the funnel-shaped tube the "plag" through which pass the wires that form the electrical connections to the internal elements of the tube.

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SCIENTIFIC AMERICAN, July, 1997, Vol. No. 181, No. 1, entered at the New York, N. Y., Peet Office as second clear matter June 23, 1479, under the ang of March for, 1979, additional entry at Greenview Comm. In the served, Subscription price \$6.00 per year. Canada \$4.50, Foreign \$4.50, Manuscript are schemicted at the author's cities and cannot be returned unless accompanied by posting.

OUR POINT OF VIEW

"Self-Sufficiency"

UNDER the title "In Case of War," 1936, issue, a discussion of those strategic raw materials which this country must import because we have little or none at home and which are absolutely necessary to the proper functioning of our vast industrial empire. The list of these vital imports given in that article totalled more than two dozen at the time of publication. There is today no essential difference in the number and kinds of materials in such a list, yet there has been a momentous change in the picture. Chemistry has provided satisfactory substitutes for some of them, found ways of providing nearer-home supplies of others.

In this issue is an article which summarizes starthingly the ends to which Europe must go in order not only to be Europe must go in order not only to the clee during a possible future war but also to assist in the present conomic war. A similar motor fuel problem will not have to be faced by the United States perhaps during the lifetume of present to to there are other, no less pressing problems to be faced and solved if we are to maintain our national economy with little duruption in tume of an emergency.

A wecond article in this issue serves to emphasize one problem which we do have—that of supplying rubber, which we must import, to a large number of motistries. More important, this article also gives a linit of what we are doing to face this situation. It shows that we, too, have creatiz materials; that is, substitutes for natural products. What people do not generally know is that the business of finding something of native compounding to take the place of searce or imported necessities is important in its own right. It is this that has changed the picture alluded to above

Synthetic resins are being need now where imported tin was interto indispensable; chromium and platinum are giving way to domestic alloying matetials; organic substances are used for rubber, silk, quinine, Manila filter, are opium; and improved processes are making available hithern unworkable deposits of low grade mangance ore.

So far, only a start has been made in this drive for a form of self-sufficiency. Yet an enormous effort is being made in this direction, and it can be stated positively that, in case of a future war, we will be in a much better position to supply the materials required by industry than most people imagine.—F. D. M.

Incomparable Promise or Awful Threat?

FOR years past, screnntic writers have been pointing on the fact that if the energy known to be confined within the atom could be practically and commercially released and employed, there would be power in amounts today unknown. A handful of atoms would suffice to drive a liner to Europe and back, for example. The atomic energy of a piece of coal burned beneath a boiler by a ratio of a whole bullion to one. Such writers have usually hastened to add that there was no prospect of mails 'sever unlocking these stores of power, and some have hinted that perhaps this was pust as well.

Once more the foolhardiness of predicting impossibilities threatens to be demonstrated because, as this is written, physicists are at work on experiments that seem to contain the possibility if not the probability that the billion-to one power source is at least within view. The uranium isotope 235, when bombarded with slow neutrons, releases inconceivable energy. Simultaneously it releases more neutrons and, if uranium 235 isotope be present in quantity, the result of this trigger effect is a chain reaction of far more than terrible power. Fortunately, uranium 235 is only one hundredth as common in the orcs as ordinary uranium 238, else exceedingly dire resultsexplosions of magnitude heretoforc unknown-would automatically follow unless proper control were provided.

Here, in this last clause is the question that is worrying the physicists. The minute a new force for man's benefit is found, individual examples of the genus homo begin plotting to use it as a destructive threat or in actual destruction for their own selfish, reckless ends. First impulse, then, among physicists is to abandon the experiments. Second thought shows that this would be merely to abandon them to these self-seekers, the war-makers and world conquerors. The physicist cannot stop. At first it might seem that, by an agreement, all the physicists could simply drop the matter and that this would end it. But the physicist is no more cer-tain in advance whether his discoveries will be a curse or a boon than anyone clse. He is a part of the stream of only slightly foreseeable human events. He cannot control his own discoveries, once they are given out, for he is far outnumbered. And if the human race won't leave its new playthings alone, and gets badly hurt, that's its own funeral, In a few years we may have the answer .- A. G. I.

Television Problems

COMMENTS, criticisms, suggestions, questions regarding television have been reaching this writer in increasing numbers since the beginning of regular scheduled television service in the metropolitan area. Two phases of the subject stand out above all others as being of great apparent interest to a large number of people. The first has to do with the service range of transmitters and the second with the possibility of constructing sets in the home workshop.

The service range of a television transmitter, under present conditions, is severely limited and that's all there is to it. With the extremely high frequencies that must be used to bring television signals into the home the range of the transmatter is practically limited to the optical horizon. Freak reception may be recorded occasionally beyond this area, but such freaks do not alter the situation as far as the average person is concerned. In other words, it must not be expected that the DX nights of early radio broadcasting will be revived in television reception. If you live within the service area of a television transmitter, you can enjoy television reception; if you do not, the only thing you can do is to wait until such service is made available in your locality. It would be useless, for example, for a resident of Texas to purchase a television receiver with the expectation of being able, even occasionally, to receive television broadcasts from New York City

Television receivers are admittedly expensive. They must be so because of their extreme complexity. This same complexity militates against the construction of receivers in the home workshop, although kits of parts are available for those hardy souls who will try anything once. Just because a person once built a satisfactory radio sound receiver, however, is no indication that he will be able to achieve the same degree of success with a television set. The skill required is far greater than that called for in constructing even a very elaborate sound receiver. Then, too, there is the element of danger from high voltages (kept under "lock and key" in commercial tele-vision receivers) that might lead the constructor into serious trouble.

Does all this seem pessimistic? It is not intended to be so, but rather is intended to present the facts as they stand. Television is bound to become an important factor in our daily lives; don't spoil it for yourself by starting off on the wrong fool.—A.P. P.

50 Years Ago in . . .



(Condensed From Issues of July, 1889)

VALUE—"I'll gave you a pound of metal and ordered you to make the most out of it, what kind of metal would you select? asked a well known jeweler. 'Gold, of course,' was the promp reply. 'I'd prefer a pound of steel,' asad the jeweler,' and I'd have it made into hair springs for watches. A pound of such springs would sell for an even \$140,000."

ELECTRIC CARRIAGE—"The accompanying illustration represents the application of a system of electrical propulsion for common roads, by means of which traffic is designed to be carried on without employing a railroad track, the steering gear being so arranged



that the wagon will automatically run parallel with the line of the conductors, ... The wagon body to which this improvement as a pilled is parily supported on a caster wheel, provided with a fork, portaled in the forward end of an extension of the frame of the body. Upon the rear sale, in this case carrying the drive wheels, as mounted a spur wheel engaged by a pinnon on the armature shaft of a motor secured to the main frame of the body. Above the road bed are suspended electrical conductors, supported by poles and brackets, and each wagon is provided with a trolley which rides upon a plan of the conductors, whereby connection is made between the motor and conductors, through a vertical shaft, the electrical switch being close to the driver."

DEVELOPMENT—"Mr. Ersatus Wiman, on the subject of telegraph and telephones, in an address before the New York Electric Club, recently said, among other things, that it was a great blessing that the telegraph and telephone were early divorced, because I do not believe that the telephone would ever have been developed to one-quarter the extent to which it has been developed if it had been deemedrat on the telegraph."

POISON—"According to Mr. Stanley, the arrow poison used by the natives of the Lower Congo district is made from a species of reasts found in that locality. The ants are dried, crushed into powder and cooked in palm oil. The exceedingly irritating properties of the poison are supposed to be due to formic soid."

ELECTRIC LIGHT—"Electricity on ships of war is purely an American idea, and was first tried on the United States steamer

Trenton in 1883 ... Soon after the system had been tested the vessel sailed on a three years' cruise, and attracted much attention as the first vessel affoat to be lighted by electricity. The success of the Trenton's experiment practically settled the question in naval circles."

TELEPHONE.—"Baltimore will be the first all-metallic circuit telephone exchange in the United States, and we predict that it will be without equal in the world."

HEART FAILURE.—"The American Analyst thinks it would be an excellent idea of physicians of the present day would invent some other reason for all the deaths which occur nowadays than heart failure. It is difficult for any one conversant with the organs of the human body to understand how any human being can die without heart failure, while the causes of the failure of the heart at death may be very numerous."

STREET RAILWAYS—"The hill recently signed by the Governor of New York, allowing the street railroad companies to substitute inchanical motive power for horses, is an important one. We hope in time to see it tead to a general use of electric motors on the roads in this city."

ELASTICITY..."Professor John Trowbridge . . . calls attention to the importance, from an engineering point of view, of making careful photographs of steel and timber at the point of rupture under a breaking load, suggesting that in this way we may learn something important on the mucb vexed question of elasticity."

WORSTED-WOOLEN—"The question is asked, what is the difference between worsted cloth and woolen cloth? The answer is: Worsted goods are composed of wool that has been carded and combed, while woolen goods are made of wool that has been carded but not combed."

AND NOW FOR THE FUTURE

(Noise Control—Science Takes the Noise Out of Our Daily Lives, by Philip H. Smith.

CHow the Boomerang, a Prehistoric Invention, Foreshadowed the Science of Aerodynamics, by A. E. Oxley, M.A. D.Sc.

CAmerican Shipping Enters a New Era in its Importance to the Nation, by H. Gerrish Smith.

(How Colors-Green, Red, Yellow-Become Clues to Life's Fascinating Mysteries, by Barclay Moon Newman.

CEarthquakes Need Not Kill—If Man Will Learn the Lessons Taught by Engineering, by David O. Woodbury



AIR CONDITIONING AND LIGHTS TENDERIZE BEEF

AFTER a long study, initiated by the Kroger Found Foundation, scientus of Mellon Institute learned many things about the action of beef enzymes that 'ripen." or tenderare, it. The final result was developed ment of a process, which make prime cuts of even the toughtest beef, involving air conditioning and use of the toughtest beef, involving air conditioning and used for the Sterliamp, the ultraviolet ray destrupter of bacteria and fungi which was developed by Westinghouse. In the photograph, the ubulual ramps are on the right wall.



A strange sight to an American; a "filling station" for Rome's 85 wood-burning buses. Small furnaces, concealed in the rear of the buses, and charged with blocks of wood cut in small sizes (or coal or chargeal), generate the gas which the motor uses

Ersatz Motor Fuels

THE dominant note in Europe today is self sufficiency; the dictates of nationalistic forces have made production of all wartime supplies of great stimportance. Under such a regime the conomic side of the situation is sub-rodinated to the necessity of muontaning within national borders the means of carrying on war measures in the face of an extensive blockade.

To the army and air forces of a highing nation, more fuel is almost as vital as man power, and since most of the nations concerned are deficernt in oil supplies, the manufacture of sub-titute fuels has been forced to a new histosiace 1937. The villingness with which Europe accepts substitutes, which permit conservation and storage of gasoline against a possible war, points the way toward operation of all civilian motors on substitute fuel so that military machines may have the exclusive use of all Europe's Desperate Nationalisms Force Use of Native Fuels...To Conserve Gasoline for Possible War...Result: Enormous Net Monetary Losses

By GUSTAV EGLOFF
Director of Research, Universal Oil Products Company

gasolme. This would be the wartime ideal. Eighteen percent of the motor fuel consumed in Europe during 1937 consisted of substitutes for gasoline. The substitution substitution for gasoline. The substitution substitution was wood and coal to compressed gases of several kinds. Offland this might seem to indicate great saving since the cost of imported gasoline is extremely high in Europe as compared with gasoline cost to American motorists. By the use of substitutes, however, Europe but approximatorly \$235,

000.000 during 1937. This was an alltime high. Yet 1938 showed an increase up to 25 percent of all motor fuel used and a loss of about \$300,000.000 through subsidies and taxes

Americans who have heard much of the plan, in this country, to use alcohol as a blending agent with gasoline, will be suprised to learn that use of power alcohol in Europe is steadily declining. The same war scare that is promoting use of motor fuel substitutes is diverting alcohol to the munitong industry where



it is a vital raw material. Furthermote, calcobol in essential in wartime for medicinal use, and motors adjusted to use in peacetime would require costly readjustments to use other fuels when war breaks out. Already, there are insufficient supplies of alcohol in Europe, othat France and Italy were curtailing us use in 1937, while Germany not only twee reduced the mandatory percentage of alcohol in gasoline but also had to import supplies of it.

Even with declining use, with alcohol constituting only 4.3 percent of Europe's motor fuels in 1937, it cost Europe that vear \$104,040,000 more than an equivalent amount of imported, tax-paid gasoline. Other substitutes made up the remaining 13.4 percent and cost \$130,826,-000 more than imported gasoline. These losses are made up by the direct and indirect subsidies on native motor fuels, by special taxes on imported motor fuels, by partial elimination of taxes on native fuels and the vehicles using them. and, in some cases, by direct payments to operators of vehicles using native substitute fuels. As is the case in any country where any one group is aided by the government, it is the public-each and every individual—who pays, in taxes, the European motor fuel bill for the favored

WOOD, charcoal, coal, and lignite are used to make producer gas in generators on many European motor cars. Compressed natural and manufactured illuminating gases are carried in clumsy tanks on some cars. Experiments have been conducted in efforts to utilize acetylene, cracked ammonia, and hydrogen. Hydrogenated gasoline is, however, Europe's primary substitute motor fuel. While this fuel is actually gasoline, it is a manufactured productmom cities coal or carbon monoxide—and is subject to the limitations of factory production.

Hydrogenated gasoline is the only one of the various substitutes which is of possible value to the United States. Small



Top of page: A producergus generator on a motor
truck in Italy, Its fuel is
wood. Center: One of the
filling stations in Germany where methane gas
may be pumped, under
5000 pounds pressure, into a car's feel cylinders.
At right: Mousting of
compressed gas cylinders
on a German gas cylinders
on a German garwing truck which draws a trailer.

about 18 cents per United States gallon. When units now under construction and designed are added to those now operating in Germany, that country's production of hydrogenated motor fuel will total about 17,000,000 barrels per year. In England, the production is about 1,300,000 barrels a year; while France is operating only a small unit producing 110,000 barrels a year. These figures may be compared with the world production of gasoline from petroleum by cracking and distillation totalling 775,000,000 barrels a year and it will be seen that only a tiny dent has been made in the problem of supplying manufactured gasoline to supplant that from petroleum.

Combustible gases of many kinds-including natural gas and gases recovered from both hydrogenation processes, from coal carbonization, and from the cracking process-are being used more and more widely in Europe. In Germany, lightweight alloy cylinders have been develop-ed for attaching to motor cars to carry the combustible gas under pressure. These are picked up as replacements in filling stations that dot Germany, or are refilled at the stations with city gas, methane, or propane-butane. It is estimated that there are in Germany 25,000 vehicles using a total of about 250,000 such storage tank cylinders. Depending on the gas used, a given vehicle using two of the tanks will travel on one filling 25, 85, or 225 miles.

The use of compressed gas as a motor fuel requires conversion of vehicles, consisting of the installation of racks to carry the tanks, a regulating valve to control pressure, and a special gas-air mixer in



experimental plants are producing a small quantity of hydrogenated fuel in this country, looking toward the time when petroleum supplies will have become so nearly exhausted as to make neccessary a supplemental supply of fuel. At present cost of production, hydrogenated gasoline is-too expensive to use in America. In Europe, this fuel, whether produced by the hydrogenation of coal or of carbon mosoude, is believed to cost

place of the carbureter. To make this conversion, the cest may be from \$150 to \$300, depending upon the size and power of the vehicle. The number of tanks upon the vehicle varies from two to eight, depending upon the type of service; passenger buses may even pull trailers to carry the tanks. Each steel cylinder weighs 115 pounds empty and 215 pounds when filled with propase-butane at a pressure of 150 pounds per-square inch. This set of 150 pounds per-square inch. This set 100 pounds of gas is equivalent to 18 gallons of gasoline.

Perhaps the oddest motor fuel used in Europe, from the American point of view, is producer gas from wood and coal. Yet terials probably come nearest to being plentiful in some countries of Europe, relatively few vehicles burn gas made from them. Drastic laws have been passed to promote wider use of producer gas and government subsidies have been granted users, but there are even yet no more than about 9000 wood-burning vehicles. In France, Germany, and Italy they consume annually 450,000,000 pounds of wood. This amount is equivalent, in motor operation, to about 18,000,000 gallons of gasoline.

Some cars are built directly for using producer gas from wood, but more often gasoline types are converted by adding a stove to burn the wood, cooling pipes, filtering agent; tank to collect condensed water, tar, and acids; and sometimes a blower. The cost of this conversion may range from \$300 to \$500.

Georgemes, as the units are called in Europe, perate by hurning word, wood charcoal, coal, hgaite, or briquettes in a hight steel cylunder which may be lined with a ceramic insulation. The fuel is loaded in through an opening at the top and lighted. Air is admitted through an opening at the bottom, and the gases resulting from combustion leave the tank through another opening at the bottom.

The combustible gases are cleaned by pussing through cooling pipes to collect

At right: A Parisian taxi driver attracts currious bystanders as he loads his wood-burning taxi with a charceal-anthracine mixture. Relow: Motorman's cab and wood-burning gas producer in a French passenger bus. At bottom of page: A German bus which carries compressed gas fuel in trailer tanks





duction of France were used in this manner, it would still supply only 10 percent of the nation's requirements in motor fuel. The reduced efficiency, inconvenence, and delays in starting and for relatively frequent cleaning are other objections to the use of wood to make gas for motor fuel. Coal, in several grades, is more plenti-

Coal, in several grades, is more plentiful in Europe, and these raw materials, used singly or mixed in various ratios, could be used far more widely than at present in case of a national emergency.

Of the other substitute motor fuels used or tested in Europe, little need be said. In a number of countries, oil is being extracted from shale. This is a substitute, of course, only in the sense that it takes the place of imported motor fuel. In Italy, synthetic ammonia, after being cracked into narrogen and hydrogen, has been used as a motor fuel, but its low efficiency and high cost are factors militating against its general adoption. Acetylene has been tried and found wanting in several respects. Hydrogen, compressed and carried in tanks as is city gas, does not seem to be a satisfactory fuel.

LEARLY, gasoline would serve all motor needs in Europe more efficiently than these expensive substitutes and semi-substitutes, even under the prevailing strained economic conditions. Purely from a military standpoint, the huge loss of \$300,000,000 brought about by their use might be used to better advantage in purchasing and storing petroleum for wartime needs. The reason civilian populations will tolerate this loss is probably due to the fact that the burden is relatively small because of the smaller number of cars in proportion to population. In all of Europe, with a population of over half a billion people, there are only 8,189,335 motor vehicles as compared with 30,000,000 automobiles for the United States; or one car for every 63 people as compared with our one car for every five people.



water, tar, and acids. A dust catcher and a filtering chamber collect the colloidal particles of dust from the gas which is forced by a blower into the motor.

Despite its many disadvantages, the wood-burning motor has one point in its favor: the filling station can be any wood pile where good, air-dried wood is available. However, it takes about 25 pounds of wood to give the same distance perfermance as a gallon of gasoline. Many

wood-filling stations are scattered over France, Germany, and Italy and from them 30 to 60-pound packages of wood may be purchased. The cost is low, but any comparison with the price of gasoline is fictitious because of the several subsidies and taxes that enter into the question. Furthermore, it can be confidently said that gasogene vehicles will never prove a satisfactory saver of petroleum products; if the entire annual wood pro-



Lies-Truths

A murder suspect heing tested on the Polygraph the detector by the author. A rubber tube enterling his chest and another on his arm transmit fluctuations in his heetathing and pulse to the instrument, making record on a moving stru-

WICHITA, Kansas, sometimes is called the proving ground for the Keeler Polygraph or so-called he detector, for it is there that more persons are tested annually with Polygraph deception technique than anywhere else in the world.

The Webus instrument is owned and operated by the Police Department Each operated by the Police Poperatment Each bedetector tests, because of superteed crammal activities or because it is thought that they may be closely connected with certain craminal offenses accurately and painstakingly recorded and statistical data are compiled to measure the instrument's value in police work and to determine its accurately and inaccurately.

Since scientific he detection is comparatively new to police, and since at has only recently branched out into the commercial field, statistical data have been more or less limited and the techique of detecting deception has had to with-stand the usual doubts and prejudices met by things new. The first quetion aroused in the minds of those in authority is; "How does at work," Usually this question is followed closely by another: "What dependence can I place in such a procedure,"

The answer to the first question, of ourse, deals with the mechanics of the motrument, the thiories or facts upon which its operation is based, and the procedure used in applying the technique. This question was compreheninger. This question was comprehenitive Direction of Lice, "which appeared in this magazine in June, 1937, and will be given only a short explanation here.

Polygraph deception technique is based on the fact that certain emotional disturbances take place within the lody during attempted deception. These disturbances, when recorded, are discernible in the blood-pressure and respiration of the individual taking the test. The Polygraph instrument is so constructed that blood-pressure and respiration are recorded simultaneously on moving paper during the entire examination. The second question can be answered only by application of the acid test-ic-alis. Heretofore, sufficient statistics have not been available, and therefore a comprehensive and factual answer could not be given. Now, however, with 4000 recorded examinations on file and a complete research of cases made during the years 1936, 1937, and 1938, it is reasonably safe to state that the he detector is playing a most important part in weeding out the guilty from the large number of persons whom police find it necessary to mixetigate.

Sepregating the 4000 examined subpress into nints of "routhful" and "untruthful," at was found at Wichia that 3020 were ablis to produce "clean" records—those in which no deception was displayed, Of this number, 1600 were transvents or vagrants picked up in the athoral yate or found loutering about the city streets. They were questioned about crime in goneral, and usually were released upon the completion of records which indicated that they had not committed any crimes and that they were and 'wanted' by other authorities.

ON the other hand, 974 of the 4000 produced records which indicated that they were not telling the truth, From this number, police were able to secure 537 full confessions to the crime under investigation. Subtracting this number from the 974 in the supposed "untruthful" group, there still were 437 to be disposed of. Of this number, 287 were released because complainants refused to prosecute or because sufficient evidence to prove guilt was not obtainable. The remaining 150, police took through the courts. Of this number, 112 were convicted, 34 were acquitted, and four cases still are pending.

The foregoing figures, reduced to a percentage basis, show that 55.1 percent of those whose records indicated deception confessed their crime; that 74.7 percent of those whose records did indicate deception, but who did not confess, were successfully prosecuted in court;

THE he detector described in the accompanying article is one of four types discussed in The Journal of the American Medical Association (Chicago, Jan. 29, 1939, page 354), Where do he delectors stand in general? This is largely a mutter of ominion. One opinion, on the conservative side, is stated by the medical journal named above, which finds that many of these machines are being exploited by non-medical men although they involve the most complicated forensic clinical principles, and that sometimes instruction is too buef. The same tournal recommends the tollowing books on the subject: "Legal Psychology," by H E. Burn; "Lying and Its Detecnon," by John A. Larson in col laboration with Geo. W. Huney and Leonarde Keeler; "The Psychology of Feeling and Emonon," by Christian A. Reichsmid; "Trial Technique." by Irving Goldstein; "The Lie Detector Test," by William Marston; and "Scientific Methods of Crime Detection in the Judicial Process." by J. Edgar Hoover. -The Editor

also that approximately 3026 persons, who were either suspected of cime or came under police inheritation, were spared the necessity of long incarcerations to permit the police to check up their many-angled stories.

During the accumulation of these reords 31 persons, because of mental or physical ahnormalities, produced records which were considered uninterpretable by the operator. Otherwise stand, 99.9 percent of all persons examined were able to produce records upon which a defantic and immediate decision could be made.

Space will permit the discussion of only a few cases, hence random records have hern elected. Take, for example, the graph produced by a young man. A salesman had parked his automobile in the down-town district, hidden a bag of money in the glove compartment, locked both the glove compartment and the car doors and gone about his business. Returning some two hours later, he found the car broken open and the money gone. Later in the day police picked up this suspect. The young man vigorously denied any knowledge of the heft and was requested to submit to

Now that the Lie Detector Has Been Used by the Wichita Police for Three Years, How Successful Has it Proved? . . . A Progress Report

By THOMAS HAYES JAYCOX Polygraph ("Lie-Detector") Operator, Police Department, Wichita Kanaas

Polygraph deception test technique. The graph below shows a "close-up" of the subject's record where he was asked questions concerning the stolen money, Notice the violent deviation from the 'normal" in both the blood-pressure (lower part) and respiration (upper part). Immediately upon completion of the test, the graph was explained in detail to the lying young man. He confessed and led detectives to his home, where the stolen money bag had been cached

The lower graph presents the reaction m a general investigation where police had charged no definite crime against the subject. These tests are given to hobos, vagrants, and to known criminals who are checked up from time to time. The operator simply goes "fishing" with his subject and often the results are more than worth the time and effort expended

- 9 Have you stolen anything during the past year?
- 10 Have you answered all questions truthfully?

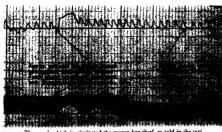
In a typical instance using these questions two young holos were brought in for tests shortly after they had alighted from an incoming freight train. Both young men steadfastly insisted that they had never before been arrested and that they had committed no crimes But their l'olygraph records had an entirely different story to tell. Notice in the graph the responses in blood-pressure and respiration (shown by arrows) at point 4, where one of them was asked the fourth question, "Have you ever committed any erimes and not been caught "" Notice how similar reactions were displayed at points 5, 6, and 9, corresponding to the respective numbered questions. Obviously, the young man was lying when he answered negatively to these questions. Interpretation of his reactions indicated that he had committed a crime and that the crime was burglary of a house or store, as shown by his answer to question 5. He was wanted by the authorities, or thought he was (shown in question 6) and he had stolen something during the past year (question 9).

With these deductions the operator proceeded to question the young hobo, and soon the facts began coming out. When apprised of his reactions, as shown by the instrument, and when their meaning and reason were explained to him, the hobo confessed. His home, he admitted, was in an adjoining state. He and his companion had left there only the day before. Just prior to their leaving, they had broken into a dwelling house and stolen a pistol. The pistol was neatly hidden in a roll of clothing he had been carrying under his arm.

These two cases, extracted from the 537 confession cases previously mentioned, do not by any means tend to reflect that the he detector is valuable only in nunor thefts or lesser crimes. Among the 4000 cases now on file are 52 murder investigations, one of which is the wellknown Wight case. To the he detector goes the credit for "cracking" this strange enigma and searching out the murderer from among nearly 50 suspects, as well as locating the murder weapon.

On the other hand, the he detector is not a panacea for all criminal ills. It is simply one of the many tools used in scientific crime detection and, like the doctor or physician, the operator is not immune from an occasional misinterpretation of the symptoms.

Yet with the 55.1 percent confession rate, and the successful prosecution of 74.7 percent of those who refuse to admit the truth, it is safe to assume that the lie detector, in police science, will average a high score in precision and accuracy. This assumption is true, however, only where a skilled and well-trained operator is conducting the tests. The instrument in the hands of a novice would be much like calling in a truck driver to diagnose some physical ailment-the recipient of his diagnosis would suffer.



The graph which incriminated the money bag thief, as told in the text

A questionnaire is used which includes nearly every type of crime listed in the statutes. For example:

- 1. Is your home in Wichita?
- 2. Do you live in Kansas?
- 3. Is this the month of ... 4. Have you ever committed any
- crimes and not been caught? 5. Have you ever broken into a
- house or store for burglary? 6. Are you wanted by the authornics
- anywhere?
- 7. Have you ever held up and robbed anvone?
- 8. Have you ever stolen an automobile?



Breathing and blood-pressure fluctuations of a hobo under questioning

THE FUTURE OF NAVIES

TEXT in importance to the capital ship discussed last month comes the aircraft carrier, that extremely vulnerable floating aerodrome the existence of which in wartime is looked upon as hazardous, but which many naval officers regard as likely to become as important as the battleship,

Carriers: Since the World War, progress in carrier flying has been such that landing accidents are very rare, and all the elaborate arresting gcar has been discarded. Very long and wide flight decks are still necessary-since in rough weather the pilot has to land amidships where the ship's motion is least and yet the plane may have a sufficient runwith ample beam so that an error in judgment, side-slip, or a rolling deck do not lead to a side crash. But "the bigger the ship the better the carrier" is no longer an accepted axiom, and both small and medium sized vessels are now being built instead of those of maximum dimensions so favored at the time of the Washington Treaty. A limit of 33,000 tons displacement, with guns no larger than 8-inch, was then agreed to, these limitations resulting in the U.S.S. Saratoga and Lexington and the Japanese Kaga and Akagi-inimense vessels carrying cruiser armaments and a considerable weight in waterline protection. When the Treaty came into force, Britain had just completed the Hermes of 10,850 tons only, steaming at 25 knots and having an official complement of but 15 plancs, while Japan had passed the 7470-ton Hosyo into service—a vessel of

In the Hermes, the deck was of sufficient width to allow for the funnel to be brought up through an island superstructure which an experimental canvas erection on the Argus-a clear-deck ship with side smoke ducts discharging at

original design housing some 25 planes

and capable of 25 knots.

Second of Two Parts . . . Carriers, Cruisers, Destroyers, Submarines . . . Ships Building . . . Dimensions, Armor, Armament . . . Comparisons

By OSCAR PARKES

the stern-had shown to be a practical solution of the disadvantage of hangar heating, with restricted housing accommedation, experienced in both this ship and the Furious, But in the Hosyo, the deck was too narrow for this arrangement and recourse was had to small hinged side fininels which could be lowered to a horizontal position during flight work, as in the U.S.S. Langley, converted about two years after the Japanese ship was designed.

At the present time, both systems are in favor, while in the matter of size a considerable latitude is observed, depending upon the specific service for which the carrier is designed. Cost and vulnerability militate against maximum dimensions and the latest designs range from 10,000 to 23,000 tons with a wide variation in features dictated by national requirements.

THE huge 27,000-ton Kaga and Akagi, of Japan, have recently been reconstructed, the alterations including a lengthening of the flight deck by some 150 feet so that it now extends to the bows; shifting of the forward 8-inch guns formerly carried in two turrets on the lower flight deck to casemates in line with the other six such guns on the main deck aft; addition of many machine guns along the topsides; and, in the case of the Kaga, an alteration in her funnels. Formerly she had great trunks from the furnace uptakes amidships, along the outsides of the hangar, discharging as bell-mouthed vents aft: these have now been replaced by a brace of curious side trunks amidships below deck level, one of which curves up and the other down-a system tried out and retained in the Akagi. During flying operations, the down trunk is used, the furnace exhausts being discharged away from the ship by an admixture of pressure steam.

In the Ryuzyo, built between 1929 and 1933, an attempt was made to produce a carrier of small displacement but able to house 25 planes. Thus upon a hull 548 fect long and drawing only 151/2 feet, with a beam of 601/2 feet, a huge hangar was erected with six pairs of 5-inch guns and numerous machine guns along the topsides. She also had a pair of side funnels amidships and made 25 knots on trials. But, in practice, she has not fulfilled expectations, having proved a bad sea-boat; hence, in three later carriers, Sorvu (completed 1938), Hirvu (completing), and Koryu (building), some 3000 tons have been added to the displacement, yet the general characteristics of the Ryuzyo are retained. While in the Ryuzyo, the ratio of length to beam is 9 to 1 and beam to draft 4 to 1, in the Soryu it is 10 to 1 and rather more than 4 to 1, respectively, her dimensions being 6881/2 by 681/2 by 161/2 feet.

Most Japanese types appear to run to abnormal dimensions, and these ships seeni to be asking for trouble. Compare







Japan's 8500-ton cruiser Kumano mounts five triple 6-inch turrets. Torpedo tubes are in curious ports by the main mast

them with the U.S.S. Wasp, of 14,700 tons, which is of the same length as the Soryu but has an 81-foot beam and draws 20 feet! Moreover, the Wasp's length is "water-line" whereas in the Japanese ships it is understood to be "between perpendiculars," so that the overhang of the stern from sudder pintle to counter must be added-probably another 30 feet. Such a long, narrow, and shallow hull, surmounted by a great wind-trap of hangar, does not appear to be a very happy conception, although the Japanese designers aim to increas stability by a marked flaring of the hull for three quarters of its length and the fitting of gyro-stabilizers,

These '10,000-ton Japanese carries are reported to carry 30 to 40 planes, lave a designed speed of 30 knots, and mount 12 5-mch guns. More weemly looking than the Ryuryo, their sides have been spared that bookage of sponsons, platforms, pillar supports, and cluttered control positions which disfigure that ship; the funness are small trunks on the starboard side only. Apart from a small patch of armor over the engine and boiler rooms, they are unprotected against surface attack although well armof for sky defense, and well represent a type of small carrier which has many advocates.

In the Ranger (completed 1934) the Construction Bureau of the U. S. Navy provided accommodation for 75 planes in a ship of 14,500 tons with a speed of 29 knots and armed with eight 5-inch guns. An island superstructure with bridges, control positions, and a light tripod mast was placed on the starboard 'midships, with three hinged funnels on each side toward the stern. The leeward set are used to keep the deck free from smoke and heat eddies, Following her came the Enterprise and Yorktown of 19,900 tons each, carrying over 100 planes at 34 knots. These are generally enlarged editions of the Ranger but with a much larger island built around a most imposing funnel as in the Saratoga. These ships have catapults on the flight and hangar deck forward so that aircraft can be shot off without having to raise them to the upper flight deck. Frotection is limited to an armosed deck and some plating amidships over the boiler and engine rooms, sufficient only to keep out small projectiles since their metier will be to avoid action and rely upon a protecting screen of ships.

A return to smaller dimensions has been made in the Way and Homet, now building, which are 14,700-ton vesselvhousing 75 planes. Presumably each are allowed in the are a island superstructure and fundl to stat board, as this appears to be best solution of the furnace uptake problem when practicable. There will be same armament of eight 5 melt guns; and they again are intended to be carriers pure and simple in distinction to the new Genman craft.

THE German Graf Zeppelin, recently launched, and "B." still on the stocks. were laul down in 1936 and are Germany's first attempt at carrier construction, which was forbidden to that country under the Versailles Treaty. Actually, so long as her naval operations were confined to the Bultic and North Sea, she had no need of such craft, as shore stations could provide the formations required in these waters. Neither was transport required to overseas stations, as she has none. Hence, when it was decided that a ficet air arm should be built up, the question as to what type of carmer was needed called for special considerations. Freed from coast defense duties, the new fleet was intended for the high seas, and guerre de course was to be the main function; hence carriers would have to be specifically designed to that end. They might act in company with the big ships, or on their own after being escorted through blockaded areas either by surface ships or submarines or both. Yet when attacking convoys, they would be compelled to face enemy escorts of certainly cruiser tonnage; to fight with any prospect of success, a cruiser armament, in addition to a heavy sky defense, would be a first consideration. To keep out the enemy's shell and to localize hits means armor and subdivision of the hull proper by heavy plating, which absorbs a lot of tonnage; high speed under economical power means a long ship, with adequate beam and draft for proper sea-going qualities in the Atlantic, and a high freeboard. There would be no call for a very large unmber of planes to be carried, while a small target would be a sensible advantage. Therefore hanger space was limited to 40 planes. Working upon these death-create the Cermans have produced a new conception which is bound to influence naval warfare very considerable.

Displacing 19,250 tons, the Graf Zeppelin is 820 feet long between perpendiculars-about 70 feet longer than the Yorktown (p.p.) -881/2 feet in beam, and 181/2 feet draft. The hull is simple and plain, four decks high, surmounted by a two-deck superstructure along which runs the flight deck, This falls short of the bows as in the Ranger, so that a hangar catapult is probable, apparently there are to be catapults on each side of the flight deck forward. Sixteen 6-inch gins will be mounted, two aside in deep embrasures up forward and again in sponsons towards the stern, with the rest-so it is reported-in twin turrets fore and aft of the island superstructure as in the Saratoga, These guns will all have high-angle elevation. Ten 4.1-inch and 22 smaller anti-aircraft guns make up a splendid all-purpose armament. fitting her for cruiser duties or for beating off air attack.

Forty planes will be carried by the Graf Zeppelin and 'B" and the designed speed is 32 knots. No details as to protection are a saliable but launch photos show an end-to-end armor belt and their hulls will probably be built on cruise principles. From these details, it will be seen that, when operating on the trade crutes, these two ships will introduce novel and difficult problems in the matter of counter measures.

Incidentally, it has been disclosed that Germany's planes can be equipped for mine-laying, the mines either being dropped form the air at low allitudes or released from sepalanes riding on the surface. The torpedo planes have 16-inch and 17.7-inch torpedoes bloaded with 330 pounds of T.N.T. and 400 pounds of Novit, a new explosive. These are released at 20 to 50 feet above water, and both types have a range of 2200 yards at 45 knots with gyroscopic adjustment such that they run in straight, ziezar, or



Setting the destroyer pace, France's Mogador, a "cruiscrette," mounts eight 55-inch guns and makes 39 knots

spiral courses. High explosive bombs vary from 110 to 1100 pounds, and therare armor-piercing bombs, gas and phophorus bombs for use against personnel, and delayed-action 110-pound bombs for antisubmarine work.

Having laid an experience of something like 20 years in the design and construction of carriers which has covered a wide variety in types, and every opportunity in the matter of trial and error over a wide field of experimentation in design and equipment, the British Admirally has seen fit to revert to a type even larger than the Courageous which, a few years ago, was considered as an 'out-size' not likely to be repeated The 22,000-ton Ark Rojal has recently been passed into service and five more about 50 feet longer and 1000 tons heavier are now on the stocks

This latest type of carrier is 800 feet ong over all. 94 feet beam, and 23 feet mean draft, that is, about 88 feet shorter and 11 feet narrower than the American and 11 feet narrower than the American aircraft and an armament of 16 4 5-inch dual purpose guns, a sky defense of swinnlighe pompons, and cight multiple machine guns. According to present standards of arming, this is a very heavy equipment, but could only be used against destroyers and aircraft.

The effect of eight-barrelled pom-poms against destroyers has yet to be experienced, but in the opinion of torpedo officers they will have a devastating effect, being able to pierce plating and beilers, gun shirdas, and piping with such an overwhelming insilade that no previous experience will rapid-fire guns can be compared with it. The writer has seen a multiple pom-pom battery open fire a pulpor radio-controlled arcraft at such a beight that they could be followed only with a powerful pair of glasses. There was a thunderous rolling—not the expected stacets of machine guns, but a poeted stacets of machine guns, but a

continuous roar. In a few moments, a plane was twisting and tumbling down from direct hits, and was retrieved riddled.¹

The 45-inch is a new (aliber, fust mounted in the 1th Royal, which would appear to be rather an unnecessary substitute for the 47-inch. These guns are paired behind shields in side sponsons just below the level of the flight deck and have almost uninterrupted arcs of sky fire.

Sixty planes are carried in the Ath Royal, the hangais being arranged on two decks with three lifts transporting them to the flight deck. At the bowwhich flares out to almost the extreme width of the deck-there are two cutapults, with the deck between them ramped down to give a clear runway. The stern is quite an extraordinary structure with the end of the flight deck carried aft far beyond it as a fan-tail to facilitate landing. Apart from having a plated-in forecastle and stern section, the Ark Royal resembles the Courageous and. being actually a deck higher than the Saratoga, presents an immense target. Otherwise, she has no special points of interest in general design.

The French Joffre and Painleve, now building, are to be of 18,000 tons and are reported as designed for 32 knots. No details are as yet available and they will not be ready until 1941.

Italy has no need for carriers, as the Mediterranean can be covered from her shore stations.

Cruisers In designing her cruisers, Japan has sought to compensate for an agreed interiority in numbers, under the Naval Treaty, by installing superior armament in each ship. This has meant, in general, an increase in length to accommodate more turrets, with additional beam to give stability, and a necessary reduction in draft to keep displacement within Treaty limits. Her low free-board hulls, well sheered forward and tailed down aft, flared at the lows and along the water-lime, surmounted by wend tower masts, a serried line of turrets, and wildly raked and twisted funnels, present profiles which cannot be mistaken

In the six ships of the \$500-ton Magam class, commenced between 1981 and 1935, was insoluted an armainent of 15 distribution that the six ships and the wing catable, all of which, in conjunction with a long center-castle and considerable plannjer in the nature of bridgework, made the first of the class insatisfactors exabouts. The two last, Tone and Thuma, will carry only 12 6-inch guns, and have been considerably modified in other ways in order to regain the first consideration of all warships—sea-going abilities—

Five other cruisers are also reported as being under construction. These are 7000 tonners and by Japanese standards could carry 10 6-inch or a greater number of 5.5- or 5-inch guns. The 100pound, 6-inch projectile has always presented a handling difficulty for light weight Japanese seamen, and this caliber was retained only because of the adoption of power-loading. But, since power in place of human energy means a great increase in both cost and displacement, a reversion to a smaller, faster firing, man-handled gun, which is almost equally efficacious against present-day featherweight hulls, is probably being considered in Japan for the new 7000ton ships as it is in Britain for the Dido class

Such cruisers would make admirable commerce raiders or convoy guardians and it must be remembered that, in wartime, Japan will be vastly concerned with the malaneance of communications between her ports and the mainland of China whence all supplies of necessary minerals will be drawn. Four 8000-ton light cruisers were in cluded in the 1937 United States program and these Atlantas are to carry 12 6-inch gams of mly 47 caliber as against the 53-caliber, 6-inch gams in 80-maha, the aborter precedeing a dual-purpose of the state of the second state o

In England, at present, there are 21 light cruisers under construction of which the Edinburgh and Belfast are en larged editions of the 9100-ton Southampton class. They carry the same armament of 12 6-inch guns but the after turrets are a deck higher and the boilers are moved 50 feet aft to bring the catapult between the fore finnel and the hangar. Considerably more interesting are the nine Fig. class of 8000 tons, but also armed like the Southampton and steaming a knot faster-the first British cruisers carrying an adequate gun power for their tonnage to be built since the War. In the four triple turrets are 12 6-inch guns, with eight 4-inch anti-aircraft guns amidships and multiple machine guns on top of the hangars each side of the forward funuel. There is a patch of armor amidships over the engine and machine rooms, with continuations fore and aft along the waterline 1 to 5 inches thick, with 2-inch armor on the turrets, so that these ships have a very fair measure of protection. Speed will be 33 knots with about 1700 tons of oil fuel.

The 10 ships of the Dido class, of 5450 tons each, represent a small, cheap, and well-armed type which can be hult in quantity—a very necessary qualification for a cruiser design. They are slightly enlarged editions of the Arcthusa—which carries aux 6-inch guns and is not very favouably recarded. In the new ships, a

larger armament has been achieved by the introduction of the \$2.5 inch gun, ten of which are mounted in five twin turreds, there being forward on stepped levels and two aft so that say guns can fire head and four astern with wide ares on each beam. Naturally, such shape can be solved by lightly practeed, having Jische gun-louse armor and 2-inch plates amidships, plus the install armor deck below water. With engines of about 70,000 horsewer, the designed speed is to be 33 knots, are the designed agency in the 33 knots, as standard British figure for envisions.

There are under construction three medium size French cruisers of the De Grasse class, which will be more or less replicas of the British Fin-8000 tons. carrying 126 mch guns in four triple tor-1ets, eight 3 5-inch anti-aircraft guns, and four planes. No details as to protection have been issued, but these ships should be almost as well atmored as the Gloire class recently completed, with 3 to 41/2inch plate over the engines and boilers. 214 inch decks, 51/2-inch on turret faces, and 2-mch sides. Within recent years, France has been obtaining very good value for her displacement in all classes, and the De Grusse promises to be an excellent investment

I IP to now, the Treaty has limited Ger man cruisci displacement to 6000 tons and 5 9-inch guns, but in the vessels now building, her constructors have gone to 10,000 tons and 8-inch guns for the Blucher and Scydletz classes and 7000 tons for a group of medium size mounting 5.9 inch guns The Blucher and Admiral Hipper are 640 by 70 by 151/2 feet, compared with 588 by 6134 by 191/2 feet of the American Astoria, and will carry eight 8-inch guns in four turrets with 12 41-inch guns and 12 torpedo tubes There will be one catapult and three planes, with hangars anidships. A high speed is not aimed at but with the new, very high pressure boilers, which require about two thirds of the normal hull space, a speed of 32 knots is expected. Launch photos show, from first to fourth turrets, a main-deck belt which is said to be 5 inches, with light bow and stern continuations—in which case they will be the best protected of the Washington cruisers aftest

The second group, Prinz Eugen, Seydhtz, and "L," arc 6541/2 hy 71 by 15 feet, being longer, broader, and with slightly less draught for the 10,000 tons. A few months ago the writer was informed that the Blucker class were being changed to nine 8-inch guns, but as the name-ship is retaining her original armament, it is possible that the Prinz Eugen trio will carry the heavier armament in three triple turrets. It is worth noting that in these ships the Germans have increased beam and diminished draught beyond even the Japanese ratios, and their sides are markedly flared amidships as well as at the extremities, so that, as sca-boats, they would seem more suitable for the North Sea than the Atlantic.

Of the four 7000 tonners, nothing is known except that they will probably carry mae 59 meh guns Blucher and Happer are to be completed this year but "M" and "N" (7000 tons) were not laid down until 1937 and 1938, and "O" and "P" are to be legun this year, so that none of these may be expected to join the strong until 1940 or 1941.

Since the completion of the two Italian Garibaldis in 1937, no critisers of large or medium size have been laid down, but a new type of fighting ship has been evolved in answer to the French 2884ton Mogador class which might be called "cruiserettes." These 12 vessels, of the Regolo class, are enlarged destroyers, or scouts, of 3362 tons armed with eight 52-inch and six anti-aircraft guns and eight 21 inch tubes, engined with 120,000 horsepower for 41 knots. They are the first warships to have a designed speed of over 40 knots. Their dimensions are: 114 by 14.7 by 13 feet so that they will be shorter, beamter, and shallower than



The British 8000-ton Fiji class of crulser: 12 6-inch guns, good armor protection. Hangars beside forward funnel



Britain needs a host of small escort vessels, such as the Black Swan, for convoy purposes

the French ships, assuming that the length is between perpondiculars. They are essentially Mediterranean ships, able to make a very high-speed gue- and torpedo-attack with weapons of cruiser calber, but without the seegong qualities of a cruiser or her radius of action At present, they mark a very interesting link between the cruiser proper and the do-stroper—an upto-date model of the "scout" which has appeared sporadically in most navies at one time or another.

Destrovers: As already noted, the line of demarkation between cruisers and destrovers has now almost disappeared The French Mogador mounts eight 5.5inch guns and 10 21-inch tubes and, with 90,000 horsepower, has exceeded her 38 knots. With guns able to exceed 25,000 vards with a maintained fire of 16 rounds. a minute, she is a most formidable craft. The French now possess 32 ships of her general type. They are employed both in the Channel and Mediterranean and have led to the Germans enlarging their destrovers to 1811 tons, to carry an armament of five 5-inch guns in single mounts and eight 21-inch torpedo tubes, and to steam at 36 knots. Thirty ships of the German Von Roeder and Maas classes are now built or completing. These have been countered by the British Tribal class-1870 tons with eight 4 7-inch guns and only four 21-inch tubes - - in which torpedo equipment has been sacrificed for gun power As destroyers proper, the British have 14 of the Javelin class building and seven of the Lightning class recently laid down, the former being of 1690 tons and the latter of 1920 tons, with a common armament of six 47-inch and eight to ten 21-inch tubes. Just how the extra tonnage of the "L" class is to be utilized remains to be

seen-probably in increased anti-aircraft

For many years the Japanese have been in the forefront in destroyer design and since 1926 have, year by year, been adding to their flotillas heavy-weights carrying five and six 5-inch guns with six or eight tubes and able to steam at 34 knots They were the first to give gun-house protection with high angle mounts, and to protect their torpedo gunners by shields. They also developed an exaggerated form of bridge, crowned by a heavy range-finder, and generally piled on topweight until the capsizing in 1934 of the Tomoduru (afterwards salved) led to a general criticism of this trend in design and a return to less extreme proportions in hull and curtail-ment of superstructure. In the eight units now building in the Kurosio class of 2000 tons the Japanese have followed the French and Italians in merging the destroyer with the light cruiser and producing a "cruiserette" carrying eight 5-inch guns and with 34 knots speed— which is well below what the United States and European Powers deem necessary for this type. But with an armament almost equivalent to that carried in Italian and French vessels of some 900 to 1400 tons greater displacement, they can afford to dispense with that extreme speed suitable for Mediterranean tactics and conditions; for Pacific purposes they should be compared with the U.S.S. Somers, of 1850 tons, mounting eight 5-inch guns and twelve tubes, steaming 37 knots, and carrying 500 tons of fuel.

Following the 12 Maury class destroyers of 1936 (U.S.), come the 12 Sims and 16 Benson classes now under construction—the latter being of 1620 tons and generally resembling the standard one funnel Maury class but with six 5incli guns in pairs in place of four singles, and the extremely leavy torpedo armament of 16 tubes, of which eight fire on each beam. American designs favor the practice of stowing all torpedoes in their tubes on deck rather than carrying half the number of torpedoes on the center-line and keeping spare ones below deck.

Submarines and Auxiliaries: As regards submarine construction, no departures from the orthodox designs have been produced by any Power, although it is reported that a Russan boat of very large size—over 3000 tons by estimate—has been seen in the Black Sea.

The British, faced with the necessity of eccorting a vast overseas traffe, have steadily added small escort craft to ther Home and Dominion navies, of which the Black Swan is the latest sample. Of 1250 tons, she mounts four twin 4-inch dual-propes guns and, with 3600 horsepower, will steam at 19½ knots. She is designed to accompany a convoy through the submarine and aircraft zone. The earlier British excort vessels were very poorly armed, being first intended to be mine-sweepers, but are now down for re-armament with six or eight 4-inch guns. Hosts of small craft-minelayers,

Hosts of small craft-minicalyers, motor torpedo boats, and so on—are being added to the European navies, but space precludes more than their mere mention. These brief descriptions of the capital ships, carriers, cruisers, and torpedo craft being built by the Powers give some indication of the tremendous activity being devoted to piling up offensive and defensive aquadrons in preparation for the hostilities now threatened through territorial demands by Germany and Italy with Japan at the Far Eastern and of the "Atal."

AIRPLANES, UNLIMITED!

THE flying machine, in an age in which automobiles roll off the assembly line like shelled peas into a basket, is still hand made. In some stages of assembly, it takes two men four hours to rivet a single square foot of a metal plane's surface. In peace time, this deheiency of our most modern transport.

and military device is a machine-age paradox; in war, it might be a calamity. For years our air corps officers, aircraft designers and huilders, and avation experts, reseming this production lag, have been praying—more fervently than ever since Munich for some method of producing planes as rapidly as automobules.

Their prayers seem about to be answerd. A new technique, developed primarily by Col. V. E. Clark, veteran designer and our Army's chief aviation engineer during the World War, and secondarily by Dr. Leo Hendrik Backeland, the father of modern plastics, with the co-operation of the Haskelite Corporation, of Grand Rapids, makes possible (unless all signs fail) a practically unlimitted supply of stout, unlimited supply of stout.

cheap, fast airplanes For a year and a half a mystery ship, cream-colored with a vermilion stripe, had been haunting eastern airports from Florida to Quebec, undergoing all sorts of weather, as well as static, impact, and vibration tests. Then, in the course of a Congressional monopoly investigation last winter, Dr. Backeland's son. George W. Backeland, a World War aviator and aviation enthusiast, under fire of a quiz into patent relationships in that giant industrial stripling, plastics, digressed from his testimony long enough to reveal the existence of a laminated plastics plane fuselage which he said could be moided and made ready for the assembly line in two hours, half the time needed to buckle on a single square foot of the present airplane's skin. This was the cream and vermilion "Clark 46." Headlines flared briefly, but Colonel Clark, returning from Europe, squelched the sensation by wireless from his ship at sea. Only now, after months of gruelling tests, does he feel that his plane's Molded Fuselages and Wings Make Possible Mass Production . . . Plastics Employed . . . 36,000 Planes a Year . . . Tremendous Wartime Significance

By FORREST DAVIS



A hint of the future: The fuselage of this plane is molded from laminated plastics in two shells, can be manufactured economically in mass production, has been subjected to severe tests

performance justifies a public report on its nature and implications. This report I am authorized to make.

HOWEVER the January revelation struck the average newspaper reader, it was no news to rival designers, to builders, plastics researchers, or the National Advisory Committee for Aeronautics. Nor did it surprise the air ministries of certain European powers apart from the Rome-Berlin-Tokyo axis. Insiders here and abroad knew that Clark, a distinguished designer who, among many accomplishments, devised the airfoils, or wings, for Lindbergh's Spirit of St. Louis, had been working at Hagerstown, Maryland, on the mass-production problem. Some even recalled that during the World War he instigated experiments on a molded plane; an attempt which was abandoned after the Armistice because the technicians had been unable to form plywood in permanently smooth compound curvatures and because the adhesives then known failed to protect wood from deterioration,

Few doubted Clark's eventual success. Here was no eccentric, long-haired inventor, but an able aeronautical engineer rated high in Wall Street as well as in his profession. His backers, since he tackled the big job in 1934, include some of the most noted industrialists and financiers in the country. Furthermore, a general feeling existed that the time was ripe for fundamental advances in the laggard art of airplane fabrication. If Clark didn't lift the curse of Adam from the industry, it was felt, some one else would and pretty soon. New, synthetic resins brought out by the plastics laboratories had given aviation, as well as a host of other crafts, novel materials and tools.

Early planes were contraptions of doped silk, spruce strips, wire, and bamboo poles. The war brought plywood or veneers bound with animal or casein glue. Plywood was, and still is, unsatisfactory, since it is virtually impossible to protect



Left: Side view of the "Clark 46," showing the sleek lines of the molded plastics fuselage. In this model, the wings are of plywood, to furnish compari sons between the two materials under operating conditions, Below: A close-up view of the molded fuselage, showing absence of rivets and other projections

wood against rot, fungi, moisture warp, and check, In 1929 arrived the light, allmetal alloy plane, which made possible transatlantic clippers and the 350 mile-an-hour pursuit ship. But the inside of each wing, each fusciage of an all-metal plane is a forest of carefully calculated stiffening frames and stringers; the outside is peppered with thousands of rivets It takes weeks, often months of the work of many skilled hands to complete such a plane. The great Douglas plant, under forced draught, needs 18 months to turn out 500 ships for the British.

NOW examine the "Clark 46," which in time may relegate metal planes to the shelves of history. Its fuselage is sleek, glass-smooth, and rivetless. There are a few discolorations and nicks on the belly, made by stones cast up from the wheels. (In the case of a metal fuselage, stones striking its underside leave noticeable dents) Otherwise its perfect flanks give no indication of the 1600 hours it has spent in the air, deliberately exposed to every flying stress and strain, to every onslaught of rain, sleet, and snow. Rap on it, and wonder at the light, unsubstantial sound. Peer into the dark interior. climb into the cockpit, and notice the complete absence of structural supports. All the space is free. And there is only a faint seam to show where the two 20foot half-shells that form the fuselage were joined together.

Colonel Clark has given the name "Duramold" to the new material from which this fuselage is made Manufactured by a secret process employing phenolic resus discovered by Dr. Backeland. Duramold, roughly speaking, is a laminated plastic similar to the glossy table tops and decorative panels often found in night clubs or cafeteria bars.

Technically, Duramold stands somewhere between the plywood built into airplanes between 1917 and 1931, and a true plastic. The difference between a



laminated and a true plastic is this: a laminated product uses organic fiber, such as wood or cotton, for its base, and employs resin as an adhesive, a forming, and a coating agent; whereas the true plastic has resin as its base and may or may not use fiber as a reinforcing filler. Practically, a true plastic requires high temperatures and enormous pressures for forming. Duramold is molded inexpensively in a die. Exactly how this is done can not be explained since the secret is well kept, I can only reason that thin strips or slicets of plywood, of long straight grain, are formed into the desired curvature, that they are then fixed into a mold, partially impregnated with a phenolic resin, and then pressed into a cohesive mass that is no longer wood nor synthetic resin but virtually a new synthesis

Duramold does not chip or corrode; it resists water, oil, and acids; and is stronger than metal, Says Colonel Clark:

"In the form of a simple thin-walled cylinder of given weight under compression, Duramold is, roughly, 10.4 times as strong as stainless steel, 3.4 times as strong as aluminum alloy, and 12.1 times as strong as reinforced solid phenol for-maldehyde resin (a plastic)." Its basic ingredients are cheap and, in part, absurdly common. Set in molds, Duramold can be given any desired shape-and will keep that shape.

The shape of a plane is all important. Experts in aerodynamics know that tiny bumps or depressions measurably interfere with the flight of a plane. In metal planes such flaws are hard to avoid; in planes of Duramold, true to a few tenthousandths of an inch, there need be none. Engineers have said that the "Clark 46" is, aerodynamically, the most nearly perfect plane they have ever flown.

And only the fuselage of the "Clark 46" is Duramold. The ailerons and rudder are of alloy; the wings are of improved plywood—used partly because a plastic fuselage was sufficient for experimental purposes, and partly because Colonel Clark wanted to compare the behavior of the two materials. Even laymen who have examined the plane have remarked the fact that, while the Duramold has stood the tests of 20 months, the plywood lass not. The wings, applied in sections—not molded on two longitudinal parts like the fuselage—show signs of repair. One joint has been damaged by the weather—or by rot.

Within a few months we shall see a plane in which wings as well as fuselage are made of Duramold, for the wings are no more difficult to fabricate. At the present stage of this new process, Duramold may be pressed in lengths no longer than 40 feet, giving a wing spread of 85 feet, ample for most military purposes. Duramold planes will be as strong as metal; more fatigue resisting, it is believed, as safe in the air; and probably less hazaidous in a crash, since wood breaks more slowly than metal under impact Under gunfire, Duramold fuselages and wings will fare better than metal once because they will have no vital structural points to be shot away.

DECAUSE of its seamless, rivetless skin, a high-speed, all-Dutamold plane will have a frictional drag no greater than glass, and will be theoretic ally 7 percent faster than its all-metal counterpart. At 300 miles per hour, this would be a gain of 21 miles.

But the revolutionary feature of this new process is, of course, the speed of manufacture At the Haskelite plant in Crand Rapids, nine men molded a half section of the "Clark 46" in one hourtwo hours for the whole member. Shipped to the Fairchild factory, only 5 hours and 20 minutes were required to assemble the entire fuselage and fit it, without filing or drilling, to the completed plane. And this, remember, was an experimental job In factory production, when that comes, the time will be cut down even further. There is no reason why Duramold wings and fuselages may not eventually be turned out as rapidly as Fords.

Colonel Clark undertook his researches as a preparedness project. Having learned a lesson from our pitifully inadequate air building program during the last war, he foresaw a period of heartbreak for the air arm in the next war while production awaited the slow, manual job of fixing stringers in airplanes and fastening them with millions of rivcts. The answer was the elimination of stiffeners and rivets, Sherman Fairchild, of the Fairchild Aviation Corporation at Hagerstown, shared his views; the chemists of the Bakelite Company advised; and the Haskelite Company, a laminated plastics firm at Grand Rapids, gave invaluable aid based on extensive experience which they have gained in the highly specialized field of plywood fabrication.

Personally, Colonel Clark is a wellgirthed, patient-woeed gentleman of \$3, with kind manners, an abstracted air, and blue eyes as cold as calculus. Born Uniontown, Pennsylvania, and cliristened Virginus Evans, Clark went to Annapolis, transferred later to the Army's Coast Artillers, fually to the Avauton Section, Signal Corps. At 29, he was made chief



Col. V. E. Clark, veteran airplane designer, who is proneering in the field of laminated plastics planes

engineer of Army avaiton, a post he held throughout the war and until he retired from the Army in 1920 to become chufceronautical engineer of General Motors at the Daytou-Wright plant. When General Motors withdrew from avainon in 1923, Colone Clark helped organize and became chuf-engineer and vice president of Quanolidated Aircraft at Buffale, designing and building more than 800 training ships there for the Army and Navy.

From the standpoint of national police, the use of Duramold, or other early obtainable plastes materials, would frequence on aluminum alloys. But what is note important, the Clark method may realize the long-standing dream of air planes as cheap and accessible as automobiles. It is not inconceivable that Clark might nor day be the Ford of the sky-ways. The fact that production of plastic airplanes have no observable limits gives his caterprise exciting scope at this juncture in European affairs.

Nazi Germany terrified the world by turning out 10,000 metal planes in one year. The democracies—including ourselves—here that it would take months, perhaps years, to overcome this preponderance. We can tumble airplane motors, instruments, propellers, fittings off the assembly line. But production logs down in the bottleneck of the great structural parts, with their thousands of man-hours and millions of rivets. The German war plane program calls for 160,000 skilled workers in the arrplane plants alone, plus 240,000 more to make parts and metal sheeting, Duramold planes will break the bottleneck. With ten sets of dies, two foundered men in a factory overring one city block could baild enough Duramold fuselage, wing, and tail shells for 300 planes a month; with 100 dies, 2000 workner, only semi-skilled at latt, could, in one year, mold and assemble 36,000 Duramold planes.

THESE things are just around the bend of the future, Colonel Clark, long a pioneer, has rivals Glenn Martin. who built hedgehoppers contemporaneously with the Wrights and Glenn Curtiss, has been conducting research in his Maryland plant for two years, and has established a fellowship at the Mellon Institute under Dr. William L. Rast, with the hope of evolving his own plastics type ship. Another group with a dozen chemists and engineers is at work at Hasbrouck Heights, N. J., under Eugene L. Vidal, former Director of Aeronautics in the Department of Commerce. They have already molded scaplane poutoons which are now being tested by the Navy. In Europe, the race for solution of the problem of mass production planes is furious, the contestants being England, France, Germany, Italy, Holland, and the U. S. S. R. The English De Havilland Company leads in research, Plastics propellers-lighter, stronger, and cheaper than metal-are being produced in England and in the United States. The German Heinkel Works is supposedly making three planes a day of plastics plywood panels-which is primitive compared with Colonel Clark's achievements. Another German firm is said by the British Aviation Journal, The Aeroplane, to be installing 12,000-ton plastics molding presses, possibly large enough to form structural airplane parts. The implications of all this are tremendous When the new science of plustics has helped solve the problem of mass production of planes, the winged fear that made Mnnich possible need never be repeated No one nation will be able to cow another from the air for long. Portugal and Peru, if they wish, may have air fleets as large as those that terrorized Europe last September. Preponderance in aviation may give way to equality; planes may become as commonplace and unimportant in the balance of war and peace as rifles are today. The only possible superiority in the air may depend on morale, flying skill, strategy, and a ready supply of petroleum. If peace lasts until plastics planes are as much a reality as Fords, their sheer quantity may help to keep the peace. And to peacetime avia-tion, their cheapness, durability, and steadiness may open up as yet undreamed of vistas.

WHAT KEEPS THE STARS SHINING?

READERS who have had the patience to follow our story of stellar energy into a third installment may be excused for asking what dramatic conclusion justifies so long a tale. So far, we have built up the situation, and shown that the climax of the play must be a transformation scene, in which atoms of some kinds combine and change into atoms of others, with liberation of the energy which keeps the stars shining. This atomic-or, rather, nuclear-interplay was first fully interpreted, very recently, by the brilliant work of Professor Bethe of Cornell. The plot is a bit complicated, and it will be well if we begin with a list of dramatis personne-that is, of the various sorts of atoms, and of those of their properties which concern the action:

The Lighter Atoms.

Name	$S_1 mbol$	Charge	Wass
Electron	e	1	0 00055
Neutron	n	0	1 00893
Hydrogen	H1	1	1 00813
Deuterium	112	1	2 01473
Helium	He3	2	3 01699
Helium	He	2	4 00386
Lithiuni	Li^a	3	6 01686
Luhium	L_1 ⁷	3	7.01818
Beryllium	Be	4	9.01504
Boron	B10	5	10 01631
Boron	B11	5	11 01292
Carbon	C12	6	12.00398
Carbon	Č13	6	13 00761
Vitrogen	NII	7	14 00750
Nitrogen	N15	7	15.00489
Oxygen	016	8	16 00000

The masses given in the last column are the values for the whole atom-to get that of the nucleus, subtract the mass of the number of electrons given in the third column; for example, a hydrogen nucleus (proton) has the mass 1 00758, and a helium nucleus (alpha particle) 4.00276. The various isotopes of the elements are listed separately. The more abundant ones are named in stalics We have now to fix our attention on the small decimal parts of the numbers in this last column. In a reaction between nuclei-whether they combine or break up-the main part of the mass is not altered-only the small "mass excess" above a whole number.1 We may, if we will, think of the whole numbers as representing in some way the "quantity of matter" (whatever that may mean) and the decimal parts the differences in the According to Bethe's Theory, the Most Notable Achievement of Theoretical Astrophysics of the Last Fifteen Years, It is Atomic Transformations

> By HENRY NORRIS RUSSELL, Ph.D. Chairman of the Department of Astronomy and Director of the Ob-servatory at Princeton University, Research Associate of the Mount Wilson Observatory of the Carnegus Institution of Washington

amounts of energy with which they are bound together into a unit. The tighter they are bound, the smaller, naturally, is the mass-excess.

It thus appears that the helium nucleus, and those of carbon and the following elements, represent configurations of low internal energy, while hydrogen is highest up on the scale (except for neutrons, which, as we pointed out last month, will be very short lived inside a star).

The transformation of hydrogen into heavier elements is therefore the main process to which we must look within the stars Four neutral hydrogen atoms have a mass 403252, which exceeds that of a behum atom by 0.02866, or one part in 141. This looks small, but if the Sun was made of hydrogen, and turned into behum, the energy corresponding to the loss of mass would keep it slinning at the present rate for 106 billion years. We have at last found an adequate source of stellar energy Other transformations would give much less, for example, to turn four behum atoms into one of oxygen (if possible) would diminish the mass by one part in 1040, and be but a tenth as effective.

WE may now-following Bethe-consider what is known about the various reactions between these atoms

In the first place, only hydrogen nuclei (protons or denterons) produce effects of importance. An alpha-particle has twice the charge of the proton, and so is more strongly repelled, and, having four times the mass, it moves but half as fast at the same temperature. It is therefore enormously less likely to "penetrate" another nucleus.

Secondly, most of the nuclei in the table can be penetrated by a proton, if hit hard enough, and transformed; but there is one great exception. Helium is invulnerable. If a proton entered an alpha-particle and fused with it, the resulting nucleus would have mass 5 and charge 3-it would be Li3. It might be, however, that as the proton entered, it knocked out a positive electron, reducing the charge by a unit; this would give He'. Neither of these has been found, experimentally; and there is very strong reason to believe that such nuclei are inherently unstable-not capable of independent existence for even the minute fraction of a second for which some radioactive nuclei endure. If two alpha-particles should penetrate one another, they would form Be" (charge 4, mass 8). This is now known to be unstable; it breaks up again into the two alpha-particles Hence helium, once formed, appears to be indestructible. Nothing more can happen to it. If hydrogen is the fuel of the stars, helium is the ashes.

Thirdly, the lighter nuclei, from deuterium to boron, react rather readily with protons. But, either at once or after two or three successive changes, the resulting products break up into helium, To take examples observed in the laboratory

Li1+H1 = 2He4; B11+H1=3Hc4 If hydrogen and light elements are originally present, these reactions will liberate a large amount of energy; but cach light nucleus, once caught, is used up, so that the process has a limit. With carbon. however, a new situation appears. As worked out hy Bethe, the first reaction is $C^{12} + H^1 = N^{14} + \gamma$

that is, a proton enters the carbon nucleus, producing a new nucleus of mass 13 and charge 7 (nitrogen). The energy corresponding to the loss in mass is liberated as a gamma-ray (y). The nucleus N13 has been produced artificially, and is radio-active, emitting a positive electron, and dropping back to charge 6.

N13 = C13 + e+

Another proton builds this up into or-

dinary nitrogen
C13+H1=N14+7 and still another into an isotope of oxygen

N14+H1=015+y This, again, is a known artificial radioactive element.

 $0^{15} = N^{15} + e^{+}$ We might expect N15 to be built up into

O16-common oxygen-but Bethe gives good reasons for supposing that, except in perhaps one case in ten thousand, the product of the next collision will break up into two pieces, according to the

Por many heavier atoms, such as Iron, there is a small "mass defect." but this does not con-cern us now

equation

 $N^{15}+H^{1}=C^{12}+He^{4}$

One of these is a helium nucleus—and the other is the carbon with which we started. We have here a regenerative process. The carbon is not used up, but re-cess. The carbon is not used up, but re-cess. The carbon is not used what wisap-peared, and been replaced by one alpha-particle. The energy corresponding to the loss of mass is illustrated in various ways, and as hiered cenergy of motion of the ejected positive electron or alpha-particle; but these will quickly be converted into energy of heat-motion in the gas.

The positive electrons, by the way, will not last long. They will meet negative electrons, and, in this case (unlike whole atoms) the two may annihilate one another—liberating still more energy.

Finally, the rates at which all these reactions occur increase very rapidly with the temperature—but, at a given temperature—but, at a given temperature and a given temperature and all amounts at a given temperature and density can be calculated in many cases from laboratory observations of the yield of the products under known conditions, and estimated in the others on the basis of a fairly extensive knowledge of the general properties of the nuclei.

Suppose now that we had a mass-equal to the Sun's, containing (like the Sun's) percent of hydrogen, and all sorts of other elements. If it started with a very large diameter, its central temperature would be low, and none of the nurlear reactions would work. It would have to contract to keep shining, and so grow hotter inside.

WHEN the central temperature reached about 300,000 degrees (according to Bethe) hydrogen and deuterium would begin to interact, and by the time it had reached 400,000 degrees this reaction would supply enough heat to keep the star shining. The contraction would then almost cease until the deuterium was used up (not entirely, because, as it became exhausted, the temperature would have to rise a little to get enough heat out of the diminishing supply). When it was gone, contraction would ensue until, at about 2,000,000 degrees, lithium became available as "fuel' called another halt. Beryllium would work at about 3,000,000 degrees, and the two isotopes of boron at five and nine. With all these possibilities, the star might keep going for a good while; but so far as we can determine from the study of the spectra of the Sun and the stars, all these light elements are rare; their total amount is but a very small fraction of the hydrogen.

When they were all gone, there would be more contraction till, at a temperature of 15,000,000 degrees, carbon began to be attacked. At first the carbon would be turned into nitrogen: but, at 18,000,000 degrees, this too would react. Bethe's cyclical process would then be in operation—the carbon would be regenerated, and act as a catalyst to turn more hydrogen into helium. This stage would continue so long as my hydrogen was left—that is, for very much longer than all the previous ones.

We should therefore expect to find the great majority of the stars in this situation—but how can we check this by observation? The test is very simple—the central temperature, calculated thus from



Hans Albrecht Bethe, professor of physics at Cornell University and originator of the notable theory

atomic theory, should agree with that de-

The rate of the carbon-chain reaction increases very rapidly with the temperature—about as its 18th power. Hence, in a star which radiated 100 times as much leat per unit of mass as the Sun does, the temperature would have to be only 14 percent higher (if the density were the same too). That is, most off the stars tool, and the same tool. That is, most off the stars should have central temperatures of about 20 million degrees.

Now it has long been recognized that the stars of the main sequence—the most important of all groups—lave all about the same internal temperature, and, when allowance is nude for the hydrogen present, the temperature comes out close to 20,000,000 degrees. Even the differences between the bright white stars at the top of the sequence and the smaller and cooler ones like the Sun are represented by the theory. Bethe gives the following comparison (central temperatures in millions of degrees):

Strius U Ophiuchi T Cresi 18.5 22 26 30 Theory 32 Observation 19 26 The theoretical values would be changed by a few percent by different assumptions as to the amounts of carbon and nitrogen present in the stars, and the observed values by different adopted "models" of internal density. But the conspicuous agreement could hardly be vitiated. Here we reach the climax of the drama. Previously we could calculate, from the general properties of atoms, that a star of given mass and hydrogen content should be of a certain brightness. Now, from the properties of atomic nuclei, we wan ean show that most stars of the given mass should also be of a certain diameter, and a corresponding surface temperature.

In other words, from the mere statement that there is a body having 330,000 times the Earth's mass, and containing 35 percent of hydrogen, we can predict that it will have the size, brightness and temperature of the Sun. We could do the same for Surius, and for innumerable other stars The Main Sequence is theoretically explained

This is the most notable achievement of theoretical astrophysics since the establishment of the relation between mass and luminosity, and deserves all the credit that can be given it.

Certain consequences of Bethe's theory may be briefly discussed in closing.

Nuclear reactions involving heavier atoms-for example, building up oxygen into fluorine-are quite possible, but they would work at an appreciable rate only at higher temperatures than the carbon cycle, and so would not have a chance to happen in the stars Bethe and Gamow have given a great deal of attention to the question whether side-reactions, which happen to only a small percentage of the nuclei in a star, may build up heavier atoms, but have found every road blocked. There is at present no explanation low such elements as sodium, alcium and iron can have been formed. We must assume that they are "older than the stars" and for the present let it go at that.

THE history of a star, after the carbon cycle is at work, appears to be fairly clear. As it gradually uses up its hydrogen, at must get brighter—and expand a little, to keep its central temperature from rising too rapidly. After a very long time (Bethe calculates 12 billion years for the Sun) the hydrogen will become exhausted, the star will once more contract and draw upon gravity. Stars of small mass will end up as white dwarfs; showed large mass will shrink still more.

Finally, the giant stars are not yet accounted for. Their central temperatures must be far too low to "turn on" the carnon cycle—unless they are built internally upon a very different model with very high central condensation. This may be true: or they may contain large quantities of light atoms, and be consuming these; or perhaps they draw upon some energy-liberating process which has not yet been duplicated in the laboratory. We must at the moment rest uncertain—and the students of the stars have still something to work out.—Princeton University Observatory, April 5, 1939.

Rubber's 'Little Brother'

AMERICANS have become so accustomed to newspaper headlines proclaiming another minor miracle in science that it requires an outstanding achievement nowadays to make them pause and take notice.

Such an achievement has come out of the laboratory of the oldest rubber company in the middle west where scenaries have brought into the world a synthetic material so closely akin to rubber that it is being called rubber's 'Intle brother' The new whistance is Konseal, and, siginfeantly, its wonders can be introduced to the world on the one-hundredth anniversary of the discovery. In Charles Goodygar over his Mas-achievets kitchen store, of the process for vulcanizing rublies.

Koroscal is not a synthetic rubber its scientific god-parents are careful to point out, for no true synthetic rubber exists



Purified basic ingredients of the new material. Limestone, coke and salt are so common that only factory conditions can limit production

in the world today, although there are other rubber substitutes. Scientists have been searching for decades for the secret of nature that would enable them to manufacture rubber cheaply in the test tube, but the quest has been catalogued with such "impossibles" as the photosopher's store. Vet Korosal, it is discovered to the control of the property of the photosopher's store. Vet Korosal, it is discovered to the photosopher's store. Vet Korosal, it is discovered to the photosopher's the photosopher's store. Vet Korosal, it is discovered to the photosopher's the photosopher's the photosopher's the photosopher's the photosopher's the photosopher's photos

This new chemical compound opens up a vast new field of uithly because it has proved its ability to operate in places where rubber never could perform It is adaptable to varied uses, and in a variety of forms ranging from the fire-resisting coating on power transmission cables to lining in hot acid tanks and the fine-

Rubber-Like Material... Koroseal... Made of Limestone, Coke, Salt... Superior to Rubber in Several Ways... Not Yet Adapted to Automobile Tires

By FLORIAN E. WOOD

textured clothing in milady's wardrobe Since natural rubber is an indispensable product in daily life, and, therefore. a vital commodity in war-time, the discovery of Koroscal is highly significant as nations rush ahead with armaments. In the United States, a number of rubber-like synthetics have been developed since the World War, but the total annual commercial consumption of the artificial products has amounted to only about 1 percent of that of rubber. Nevertheless, such scientific strides have been made with these synthetics that the price of one artificial rubber product has been lowered from \$1.05 to 65 cents a pound, while natural rubber hovers currently about the 15-cent mark

Some American chemists have been hold enough to predict, in the light of rapid developments in the synthetic rubber field, that the rubber industry could make the United States independent of the need for natural rubber in one year with a sizable expenditure for equipment to manufacture Koroseal and other synthetic, rubber-like products. They point out that it required much larger sums and many years longer to bring natural rubber to a point of wide utility.

Significantly, scientists point out that it would require an acre of rubber trees. 17.520,000 hours, or 2000 years, to pro duce the same amount of natural rubber which could be turned out synthetically in one hour by a laboratory only one acre in area. This fact alone dramatically illustrates the importance of any synthetic material which possesses qualities that would enable science and industry to substitute it in services where natural rubber long has functioned For in commercial use today, rubber is the vital sinew of more than 32,000 varied products, most of which are indispensable to every-day life.

MANY "first cousins" of rubber have bobbed up in the laboratory, but only in very recent years have products been discovered and developed which, in addition to having rubber-like physical

properties, are so chemically constituted that in many special cases they will outserve rubber. For example, acids that chew the life out of every metal except the "noble metals," and devour stone or glass with equal case, leave Koroseal unblemished. Oils that permeate the pores of many substances, including rubber, and cause them to swell, soften, and disintegrate, practice their wiles in vain on Koroscal. Oxygen, great leveller of flesh, wood, and iron, won't leave a smudge on its face: and in resistance to water, a duck's back is no better. by comparison.

Koroseal's sire is a corrosive gas and its dam a colorless flammable gas. The factor which gives Koroseal an edge over rubber is its immunity to ozone, rays of the sun, and oil—all deadly enemies of natural rubber. Howmies of natural rubber.



This elaborate gown, prize-winner at America's first Rubber Ball, was fashioned of Koroseal.

Of the mis-called "synthetic rubhers" commercially available today, only one is dealt with speciheally in the accompanying artub-. There are, in fact, three important synthetics in this class; the following paragraphs summarze their characteristics and detail the useto which industy is putting them.

Koroseal products are resistant to moisture oxygen, ozone, strong aids and alkalies, and most corosive chemicals. Typical applications are wire and cable unsulation and sheathing, textile roll covering tank lining, pipe covering, onaling for plating racks, themically-resistant tuding, impregnated fabrics.

Neoprene is used primarily hecause of its resistance (1) to swelling in oil and gasoline, (2) to crarking in santight, (3) to deterioration under oxidizing conditionand (4) to softening at fairly high temperatures. It finds application in cub pump gasoline hose, crude oil hose, distillate hose, automotive goods suth as gackets mud vibration iosulators, primting plates and tollers, oil resisting transmission and conveyor belts, oil resisting packing, and the like.

Thiokof product are noted for their resistance to solvents, lacquers, goodne, and oils; their resistance to smulght and come; and then low permeability to gases, Principal uses are lacquer hose, crude oil hose, ignition cault pump gasoline hose, ignition caller overrance, oil-prod extension code impregnated paper goskets, and priming places. The Education

ever, scientists still face sev eral problems in connection with Koroscal. There is, for example, the problem of resiliency, where Koroseal lacks characteristics of rubbet Then, too, while Koroscal can adapt itself to temperature ranges from minus 40 degrees, Fahrenbert, to plus 150, Fabrenheit, research experts hone to increase this range and to change some of its present characteristics so that it will maintain a more stable consistency under temperature changes,

The peculiar difficulty of Koroscal to react favorably ander wide variances of temperature makes it unadaptionle, at present, to automobilities, Likewise, it cannot function under conditions where abrasion is encountered at high temperatures, although at low temperatures Koroscal can withstand abrasion very

well. With the objective of effecting these improvements, a staff of 20 technical expets is at work in the laboratory of The B. F. Goodrich Company, where the synthetic was discovered, to overcome its disadvantages.

Korossal made its first commercial appearance quite insuspiciously to rid electro-plating of one of its greatest handcaps since that industry's inception. Some metal racks on which were suspended objects to be plated in electrometal than the products plated. Korossal's peculiar resistance to plating solutious made it highly satisfactory for insulating these reacks, it has found its way into the steel industry as a lining for pickling wats, and it is the only material so far dissovered that defies the bot acids which are used in the pickling of stainless.



The new material so nearly resembles rubber that it may be worked on rubber machinery

steel. Recently, petuloum engineers in the west discovered that the great underground network of pipes which transports oil many niles from field to reservoir was being destroyed by sales of the earth acting upon the metal. Koroseal came to the resour, supplying a pratective coating similar to the picking vat lining. Transparent Koroseal is superior to

any other flexible material in resisting the diffusion of certain toxic gases which unght he used in wartime. The psychological effect of a transparent Koroseal ages mask is said by scientists to lift the solidier's morale 100 percent. Another possible war use for Koroseal is its application to soldier's uniforma, by coating or impregnation, to prevent mustard gas wounds. During the World War, thousands of soldiers received life-time wounds from this vicious gas, one of the

most difficult to combat on the battlefield. Koroscal is three times more effective than rubber in resisting mustard gas.

It is evident that this new synthetic lias boundless possibilities in the field of transportation, communication, and heavy industry, as well as in countless varieties of products, including wearing apparel. It can be poured, molded, or cut, coated, a painted, impregnated, or laminated, it can be firmly attached to metal, fabric or even to natural rubber,

BECAUSE Koroscal can be made jelly-soft or hone-hard, it has an extreme range of utility. The soft form, Korogel, was one of the first products sold com mercially, it was found highly satisfactory for making flexible molds from which plaster reproductions of art objects could be turned out with great facil ity, Koroseal's indifference to oil has made it possible to create molded partfor hydraulic shock absorbers and for gaskets, cups, or plungers which must withstand oil or grease The laboratory has practically completed the develop ment of a form of Koroscal for use as a container material for liquids, such as acids and oils, which cannot otherwise be marketed without considerable pack aging expense.

Since it is waterproof, sun-resisting Since it is waterproof, sun-resisting departs of the control of the contr



Koroseal atter processing, as extruded tubing, and in film form

for sports, every-day wear, and for evening finery

Indeed, this child of the test tube takes its place alongside such notable discoveries in the rubber industry as vulcanization, acceleration, reclamation, the pneumatic automobile tire, the airplane tire, the airplane descer, and other marvels of this age of chemical transformation. And although the search for nature's secret has not ended, scientists proclaim that this wonder baby is destined to extend widely the field of usefulness of artificial rubber-like materials.

Relativity 20 Years

(Part Two)
The General Theory

MURNING to the general theory of relativity, whose most distinguishing feature is its theory of gravitation, we find a very different situation from the one described last month with regard to the special theory. While gen erally acclaimed as one of the most important achievements of modern thought, its restricted field of application has severed it from contact with the most vital advances of present-day physics. Although both theories have been the target of hosts of irresponsible fanaties, the aloofness of the general theory has made possible attacks on it by a few presumably responsible scientists-even

though it has, by and large, received general acceptance because of the few observational effects which is predicte, and general admiration as a monumental accomplishment of the human mind. In evaluating it we must be careful to seek the open way between the Seylla of blind a priori acceptance and the Charybdis of neglect engendered by the myope view of the more extreme pragmatic cults.

In developing the general relativity theory of gravitation, Finstein took his cue from the empirical fact that the mass of a body, which is a measure of its ability to resist change of motion, is at the same time a measure of its ability to attract other bodies. This equivalence of "inertial" and "gravitational" mass is now attributed to the fact that in the general theory they are but two different asperts of one and the same thing-which we may, with suntable caution, take as a measure of the "curvature" of the physical space-time continnum. This geometrization supplants the Newtonian law of

gravitation, to which it is equivalent in the first approximation, but its astronomical predictions differ from the classical ones in certain extremely minute dictails, the principal ones being the advance of the perihelion of Mercury, the bending of light passing the Sun, and the shift toward the red of light from massive bodies. In spite of the relative uniquificance of these effects in the boader exheme of things, and in part An Evaluation of the Achievements of the Special and General Theories of Relativity During the 20 Years which Have Elapsed since the First Direct Observational Test of the General Theory

By H. P. ROBERTSON, Ph.D.
Professor of Mathematical Physics, Princeton University

because of the difficulties encountered in verifying them, there has been an unfortunate tendency to magnify their importance as crucial experiments, ignoring the more fundamental and most accurately verified cornerstone of the theony the above-mentioned identity of gravitational and merital mass.

Professor Einstein seated in his confortable old reading chair in the study of his modest, old-tashioned home, smoking one of his pet pipes as he reads. Three walls of the study are lined from floor to ceiling with books and periodicals. The fourth is a large plate glass window

Even so, three three astronomical consequences have given a good account of themselves since their enunciation two decades ago, and in each case have lent weight to the theory, for even in those observations which fail to reveal decisively the predicted effects, the results are less discrepant with relativity than with classical theory. The question of the advance of Mercury's perihelion can now be answered in the affirmative more firmly than at the beginning of this period; its severest critics have never been able to establish their case against it, and the improved orbit announced by K. P. Williams of Indiana last year is completely consistent with the predicted advance. The bending of light from stars at the limb of the Sun, perhaps tech-

nically the most difficult of verification, seemed for a time reasonably established from the plates obtained during the 1919 and 1922 eclipses, which yield an average deviation but 2 percent greater than the value 1".75 predicted by the theory for a star seen just past the limb of the Sun. But Freundlich and collaborators in Potsdam, on working up plates obtained during the 1929 eclipse, were led to a deviation of 2".25 and, although an independent reduction made by Trumpler of Califorma led to the predicted value, the original authors attributed this to arbitrariness in the reduction of the observations. In any case, the evidence is clearly in favor of the Einstein effect as opposed to the smaller value of 0".87 expected on the Newtonian theory; future eclipse plates may be expected to yield a more definitive quantitative check on the theory.

The third test, the shift of spectral lines toward the red in light from massive bodies, is

so small in the case of the Sun—a shift of the order of one one-hundredth of an Angstrom—that its existence is most difficult to establish. St. John of Mt. Wilson announced tentatively in 1923 that the residuals, aiter allowing for known effects such as the Doppler shift, were more consistent with the relativistic than with the classical theory; such is also the conclusion of the recent excellent work of the English astronomer Ever-

AFTER

shed on the problem. An unexpected test of this effect was furnished by Adams of Mt. Wilson in 1925, when he found that the companion of Sirius, a white dwarf, showed a residual red-shift 30 times as great as that expected from the Sun. Now the mass of the star is known. from the orbit, to be about 85 percent of that of the Sun, and the theory of these stars indicates that its radius should be between 21/2 percent and 3 percent of the Sun's radius; the shift predicted by the theory for such a star is, to within the errors attendant upon such work, just that observed. This may be considered a most valuable indirect confirmation of the theory of relativity-or of the theory of dwarf stars, whichever is considered the more doubtful! It is often remarked that this effect is also a consequence of the photon theory of light, the shift being due to loss of energy by the light-quant in escaping from the gravitational field, this derivation is, however, dependent on the general theory of relativity, as it assumes the identity of inertial and gravitational mass for light,

WE turn now to the cosmological problem, and the speculative attempts to answer questions concerning the geometry and physics of the space time universe as a whole The general theory of relativity attributes local irregularities in the geometry—that is, local gravitational fields—to irregularities in the distribution of matter: thus the 4dimensional geometry of the neighborhood of the Sun is such as to cause a planet to pursue what we, with our traditional ways of thinking, would express as a curved orbit described under the action of the Sun's gravitational field. This raises the question of what the geometry of the observable universe might be if we were to ignore these irregularities due to the agglomeration of matter into stars or systems of stars-that is, what the worldgeometry would be if all matter were considered as more or less uniformly distributed in space. The first attempt to answer this question is that given by Einstein in 1918; on assuming that the mean density of all matter in the universe is a constant throughout space and for all time, he arrived at the view that space is closed-the 3-dimensional analogue of the 2-dimensional surface of a sphereand that, accordingly, the total amount of matter in the universe is finite. The curvature of space, which is measured by the inverse square of its radius, would depend, and in a sense be due to, the

total amount of the matter contained in the world. In order to obtain this solution. representing the world as on the whole static-the distance between any two nebulae remaining constant except for fluctuations which would iron out in the long run-it was necessary to introduce more or less arbitrarily a certain constant. The introduction of this "cosmological constant" λ is a freedom allowed by the form of the fundamental equations of the theory of gravitation, but one which is unfortunately subject to no direct observational check. Although on the hypothesis of the "Emstem universe" à cau be indirectly determined from the total amount of matter, this is an interpretation which is not valid in the more general solutions of the problem which are to be considered below

The great Dutch astronomcr de Sitter seized upon the possibility opened by the introduction of λ to consider a universe in which the curva-

ture is due entirely to the unknown constant, and in which the total amount of matter is so small as to have but a negligible effect on the curvature But, in attempting to apply these hypothetical models to the explanation of large-scale phenomena in the actual world, both met with little success. In the first place, a most surprising effect was slowly coming to light through observations on the spiral nebulae, those great systems of stars, analogous to our own Milky Way system, distributed more or less at random throughout the observable universe. For they were found, almost without exception, to be receding from our galaxy or, at least, their spectra exhibited a shift toward the red of exactly the same kind as that which would be caused by a motion of recession along the line of sight. And further, the more faint the nebula, and therefore presumably the more distant, the greater was the velocity of recession. This was a phenomenon utterly inexplicable in terms of the Einstein universe, and although it could be accounted for in terms of the de Sitter model the amount of matter contained in the nebulae was found to be far too great to be considered as having a negligible effect on the geometrical structure of the universe.

Under these circumstances it seemed most natural to seek an intermediate solution, which could explain the existence and nature of this recession, but in which the effect of the matter was adequately taken into account. A family of possible solutions—actually, as it turned out later, the most general—was found by the late



Prof R. C. Tolman, physical chemist, mathematical physicist and dean of the Graduate School at the California Institute of Technology, one of whose special interests in the world of science is relativistic cosmology

Russian mathematician A. Friedmann, in 1922, and has since been the subject of exhaustive investigations by Lemaître of Louvain, Tolman of Pasadena, the present author, and a host of others. Among the multitude of special cases contained in this most general solution were some in which \(\lambda \) was positive and space finite (at present the most favored), others in which A could be set equal to zero and space taken either as finite or Euclidean. and still others (including all those for which \(\lambda \) is negative) in which the "radius" of the universe oscillates between a fixed maximum value and a very small mlnimum. The principal problem was then the determination of just which of these models would best fit the actual observations-that is, which choice of A and the curvature would give a model which best reproduced the large-scale phenomena of the actual observable uni-Verse

THE observations which were avail-THE observations which all able for this selection, say in 1933, yielded two of the required empirical data-the red-shift constant and an estlmate of the density of smoothed-out matter. The former was obtained from the work of Hubble and Humason of Mt. Wilson, according to which the red-shift of nebulae increases 550 kilometers per second with every million parsecs of distance, and the second was obtained from Hubble's estimates of the mass of an average nebula and the mean distance between them. But unfortunately these two important results were not enough, for they alone were too weak to single out a unique solution—which accounts for the model sonsistent with these data with which we were bombarded at about this time. But all those solutions had one surprising feature in common, they all modested that the present to expansion could have gone on for at most a very few thousand million years, not much more than the age of the Earth as a obtained by studies on the radio-cartifying obtained by studies on the radio-cartifying



The Canon Georges Lensitre, of the University of Louvain, one of the first to study the red shift

of the oldest geological strate? Although such a limited time would be difficult to recurcile with most of the theories of stellar evolution, there were nevertheless other observations which seemed also to indicate a comparable age for the solar system and the galaxy, many astronomers accordingly reconciled themselves tentatively to his "Short time scale"

More recently another survey, again by Hubble, promised to supply the data needed to narrow down the selection of possible models. This consisted in counts of the number of nebulae in selected regions whose apparent magnitudes were less than certain limiting magnitudes, hve such counts, ranging from magnitudes 18.5 to 21.0, were obtained. These may be thought of as giving the number of nebulae within a certain limiting distance of the observer, A little reflection on the nature of the surface of a sphere will make it clear that, in the three-dimensional analogue under consideration, the law of merease of these numbers should theoretically depend on the curreture of space; if their dependence is sufficiently marked, it should be practicable to obtain the curvature from these observations. Now the rate of merease of nebplac with distance, from these data, is different from that in a Euclidean space, the discrepancies being so large that if they are due to the proposed effect, the curvature must be surprisingly large. In fact, so large that the only model which fits both it and the red-shift data has a most uncomfortably small "radius" (470,-000,000 light-years) and a still more limited time scale-less than a 1.000,000,000 years, no compelling way of reconciling this latter with the geological time scale has yet been suggested. But this is not the only trouble, for the mean density of matter in such a model exceeds that contuned as luminous matter in the nebulac by a thousand-fold and, although it is conceivable that the universe contains this much dark matter, we have as yet no independent justification for assum ing that it does,

TWO alternatives for escaping from these uncomfortable conclusions are at hand. First, the assumption of uniform density may not be a sufficiently valid approximation for the nebular counts, as relatively small fluctuations in the density of nebulae in the survey regions would be sufficient to account for the discrepancy without the introduction of such a marked curvative effect, this possibility has been suggested by Shapley of Harvard, who has recently published data in support of it from a survey of nebulae in the southern hemisphere Decision on this question must presumably await further data -we may hope that it can be decided one way or the other with the and of the 200 inch reflector now under construction at the California Institute of Technology The other possible way out is to seck some effect hitherto unnoticed perhaps to assume that the red-shift is due to a degradation of energy in light traveling great distances, and not to the effects of motion away from us. Although many such ad hoc explanations have been offered, it is contrary to respectable scientific methodology to accept any of them until they are supported by some independent verification

The search for a unified field theory, which will geometrize electromagnetism in a way analogous to that in which the general theory trents gravitation, has not been successful. The most promising of these was that of Weyl, at that time in Zurich, but it too had to be surrendered; his fundamental principle of "gange-invariance" has, however, been incorpotated into modern quantum theory, where it promises to be an important tool for a future quantum electrodynamics. It has been found possible to give a mathematically unified treatment of electricity and gravitation by the use of a fifth dimension. as in the theories of Kaluza of Gottingen, Klein of Stockholm, and Veblen and Einstein of the Institute for Advanced Study. but this has not in itself materially furthered the physical problem. No attempt has been made to review here the status of Milne's weird cosmological theory, nor of Eddington's unholy union of quantum and relativity theories; these theories have been attacked as representing a retion to the outmoded Aristotelian method in science—the attempt to derive natural law from a pitori principles. It would therefore seem that, although at least hatter claims to have solved many of the really outstanding problems of physics, the acceptance of the methods by which the solutions have been obtained would represent a backward step.

In conclusion, the past 20 years have seen the special theory of relativity more and more firmly established as one of the most important and useful fields of modern physics, without which much of the modern work on atomic and nuclear structure would have been materially curtailed, if not impossible. On the other hand, the general theory has had but little contact with the advancing front of phyical science, its theory of gravitation has been successful in the limited range of astronomical phenomena in which it differs from the Newtonian, but its most important achievement has been the estabshment of the identity of inertial and gravitational mass - an achievement which may be expected to grow in im-



Dr Edwin P. Hubble, Mount Wilson astronomer, who has contributed invaluable data on the red shift

portance with the advent of some adcquate theory of the ultimate constituents of matter, even though it may at the same time suffer radical modification. The rise or fall of its cosmological offshoot, the theory of the expanding universe, can be expected to have but little effect on the general theory; as long as the theory of gravitation is accepted, any attempt to approximate the real world in terms of a homogeneous background must utilize one of the models with which relativistic cosmology is concerned—even though it would constitute an awkward anticlimax if it turned out that the red-shift were due to some agency at present unknown rather than to the expansion, to which these models seem so admirably adapted!

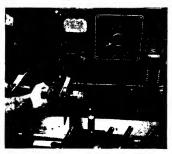
LOOKING FOR TROUBLE

Chromium plated gadgets and super-streamlining will sell an automodule, but to keep it wild without complicates a better-search who manufacturers maintain relationate inspection equipment. For example, at the right is shown one of the test complicated by one motors are maker. Steering knuckles are being magnetized prior to inspection for forging flaws. Ann annute flaw behaves like a magnet and is discovered when the knuckle is dupped into a superism of item blungs in kenson of



The illustration at the right shows an electrical thickness gage which is being used to "valiper" the engine walls. It contains coils which treate a magnetic field in the walls. The gage above measures life field strength; the scale has guidantions that indicate critiquely wall thickness in 64ths of an inch





One of the most as some and exacting jobs as that of fitting piston juris to piston. This is a function of the inspection department. The illustration at the left shows a hadroulle fixture for unserting pins. The gage multicates the pressure required to torce the jun into place. Tolerance limits are marked on the half; piston is repetched if too much to into hittle pressure is need



All photographs comies, Ponties Motor

Not only is the importion department responsible for the materials and parts which point the automobile; it must chack all master parts. At the left is shown one of the most precise importion instruments; a cam checking facture. Here it is being used to check the contons of all surfaces of one of the master cans that are used to control one manufacture et a canstant production. Also, it is used in starting the production of a new model, for by means of this instrument it can be determined evently what part of any surface is inaccurate. The micrometer scales are graduated to 2000055 of an inch

THE GREAT AMERICAN RITE

WRITING in Manasata Medicine Medicine Medicine Medicine Medicine Sperimer, 1931, a dactor actually used this tate: "The American Rite—Tonslitectomy." He was in a mood of penitence. He held that the operation was rarely performed on adults without full and sufficient reason, because they were bug enough to fight back. But children were deprived of tonais the sufficient reason and the sufficient reason because they were bug enough to dight back.

Broadly speaking, said this physician, tonsis should be removed if they are greatly enlarged and amount to throat obstruction, if they are the seat of prolonged inflammatory disease; also if they can be proved to secrete possons—which brings up the theory of focal infection. Many children lose perfectly good tonsis which have swollen only temporarily while waging defensive warfare against infection, a congestion that can recur without permanent enlargement. The tonsis of infants should seldom or never be removed—that's what the Minnesoti doctor and, take it or leave it.

The British journal, The Medical Officer, has also commented on the recent fashion of tonsil removal In October, 1932, it remarked that a mere temporarily enlarged tonsil did not merit removal. and that it was impossible to divide tonsils into septic and nonseptic Indeed, it said, we really have no way of settling whether they should or should not be taken out. In October, 1938, it was even more emphatic. A Dr J. Alison Glover had just presented to the Royal Society of Medicine "strange facts" to speak for themselves, From 1929 to 1931 almost four percent of the children in Derbyshire had had their tonsils removed, but in 1933 the number had dropped to one tentli-yet there was no deterioration in child health. In two neighboring districts in London the respective removal rates were four percent and two tenths of one percent, without discernible differences in the health records of the children.

True, the idea that tonsils should go sa nol do use Hindu physicians have removed them for ages—at least as early es 1000 nc., but the known today, stemmed from articles by Dr. Frank Billings published between 1912 and 1914 In them, Billings accribed arthritis, nephritis, and later a wide variety of ailments to infected teeth in lus Laue Memorial Lecture in 1915, Dr. Billings defined a focus of infection as a circumseribed area of infection and the control of the circumseribed area of of the circumse

What Many Doctors Think About the Too Casual and Routine Removal of Tonsils . . . The Public is Partly to Blame . . . Are Tonsils Useful?

By T. SWANN HARDING

not nearby at all. As such foci of infection, he cited particularly tonsil abscess es, chronic simus infection, gallbladder and appendix infections, and bad teeth E. C. Rosenow and others further developed his theory mainly by work on animals

In 1938, Dr. David Riesman began to speculate as to whether painless, decayed teeth also might not cause ailments elsewhere in the body. Nor is there anything wrong with this theory, within strict scientific limitations. When it can be proved that a focus of infection definitely is causing disease elsewhere in the body. the focus-tonsil, teeth, gallbladder, appendix-should be removed. Often, however, the removal takes place in the absence of good evidence to indicate that the result will be good. And so many "preventive" removals do not act preventively. Too often the operation has not good, but bad, after-effects,

CONSIDER bad teeth. In The Journal of the American Medical Association as long ago an October, 1919, you will find an article by Dr. Walter C. Alvarez entitled "A Protest Against Reckless Extraction of Teeth" which is as true today as it was then. Too often removal of the teeth or of any other supposed focus of infection has no beneficial effect upon the patient's health. "In view of the fact that the most thorough removal of focal infections often falls to cure arthritis and other diseases, let us be more honest and conservative with our patients," wrote Dr. Alvarez.

In the same journal, in May, 1923, the same doctor wrote on "Lessons to Be Learned from the Results of Tonsillectomics in Adult Life." He demonstrated, after following up more than 300 cases, that the resultant improvement in health supposed to follow the tonsil amputation often did not occur. Those who had tonsillitis were almost always helped, but those who had no sore throat or tonsillitis were rarely pleased with the result of their operation. It paid best to remove tonsile for tonsillitis or sore throat. It paid less well to remove them for frequent colds. It did not pay at all to re-quent colds. It did not pay at all to re-quent colds. It did not pay at all to re-quent colds. It did not pay at all to re-

move them on general punciples, as a preventive measure in the hope of helping headaches, deafness, callarged neck glands, rheumatism, halitosis, and so on. In many such cases health became definitely worse after that operation than before. In two thirds of the rheumatism cases there was no benefit.

In many cases, Dr. Alvarez continued, repeated operations had been undergone because certain physicians attributed symptoms to tonsil fragments left behind by others. Some had had three and four operations with no benefit. Many had had tonails removed for most trivial reasons. Another man decided to have his tonsile out because of one mild attack of constipation. He nearly died of pneumonia following the operation, Two others succumbed to the temptation because they had physicians as personal friends who would operate gratis. Another had his removed because he blinked his eyes; he still blinked after his tonsils were subtracted. Another thought the operation would cure his insomna. As a whole, nearly one in ten victims of tonsillectomy had bad results.

Some nearly bled to death in the opcration or died of pneumonia afterward Some had recurrent bronchitis, difficulty in swallowing, odd feelings in the throat, loss in weight, nervous breakdowns, increased frequency of colds, sinusitis, ear noises, or no relief from the original symptoms leading to the operation.

It should be emphasized that, according to an editorial in our leading medical pournal in 1926, both tonsil operations and mass extractions of teeth ought be classified as major operations. Broncho-pneumonia and lung abacesses can and often do follow tonsillectonies under ether. Very severe and sometimes fatal complications have also followed an occasional booth extraction. Tonsillectomy under a local anesthetic is relatively asfe. In other words, these are operations that should be undertaken only when the indications clearly justify such drastic procedure.

In short, the entire literature on tonsillectomy is convincingly consistent in showing that too many tonsils are sacrificed and the expected beneficial results too rarely occur.

Go back to 1927. In The Journal of the American Medical Association for December 24, you will find Dr. Albert J. Welch giving a statistical report on 1000 pairs of tonsils excised. In nearly half the oases no benefit to health resulted. Bacterial studies were futile because any organism having access to the mouth-and that means myriads—can be shown to be present in the tonsils. Only four bad infective or malignant lesions were found in the lot. Only 70 showed ulceration.

In 1928, a Public Health Bulletin, No. 175, appeared and the work of Dr. Kaiser of Rochester was also being discussed. Kaiser found that tonsil removals did nothing to remedy rheumatism, chorea, or heart defects in children but did reduce sore throats and head colds. The Public Health Service bulletin indicated that tonsillectomy did not reduce the frequency of sore throat among children. But it added that the words "normal," "discased," and "enlarged," as applied to tonsils, were meaningless because so differently interpreted by different peo-

N the December, 1928, American Heart Journal you will find a report on 413 tonsillectomies which had no effect on rheumatic infection. Neither were they beneficial in heart disease

In the Archives of Internal Medicine for April, 1931, Dr. Ruhy L. Cunning-ham discussed "Normal, Absent, and Pathologic Tonsils in Young Women," making a most careful study of the entire literature on this subject. She showed that all sorts of unproved hypotheses were held on the basis of poorly controlled and interpreted clinical observations. Careful statistical studies were made of 12,530 white female students, one third each with normal, absent, or diseased tonsils. The incidence of measles, mumps, chickenpox, whooping cough, scarlet fever, diphtheria, pneumonia, pleurisy, chronic colds, chorea, appendicitis operations, mastoiditis, and nasal operations was the same among the normals as among those with diseased tonsils. The group with absent tonsils actually had a higher incidence of all illnesses and operations than did either the normal or pathologic groups. Indications were that the removal of tonsils had had little helpful effect.

"A review of the literature relative to the effect of the condition of the tonsils on general health reveals a great lack of accurate information on the effect of tonsillectomy, when one considers the number of operations that have been per-formed," said Dr. Cunningham. Opin-ions were widely variant. But, even at that time, there was a sharply growing sentiment against taking the tonalls out for preventive or prophylactic reasons. The trend of these investigations shows

an unvarying consistency. We shall note but two more of them. Glover and Wilson reported in The British Medical Journal in September, 1932, on the end results of removing tonsils and adenoids from adolescents and, in general, found that they did not justify the great number of such operations. The incidence of sore throat might thus be slightly diminished, but colds were just as frequent, otitis, mustoid disease, bronchitis, and pneumonia also. No one could claim that



A doctor must be a hero to fight off some who shop for operations

the operation helped in acute rheumatic or heart ailments. The conclusions of Dr. Cunningham (above) were considcred fully supported and "a large proportion of the tonsillectomies now done in children are unnecessary, entail some risk, and give little or no return.

Finally, in The American Journal of the Diseases of Children, for August 1932, will be found reports showing that the removal of the tonsils affects neither susceptibility to diphtheria nor the incidence of scarlet fever. Meanwhile there is always a possibility that the tonsils actually perform some useful function, as Dr. Ivor Griffiths of London suggested in The Lancet for September 25, 1937. In some cases, said Dr. Griffiths, treatment of the sinuses would give the relief expected from tonsil removal. Removal of tonsils does not improve cases of middle ear disease, nasal catarrh, or acute explosive snoring. He then propounded the theory that the function of the tonsils was to excrete into the pharynx certain organisms that pass into them from the sinuses via the lymphatic glands. Hence tonsils should never be removed for nasal catarrh, Various experiments on dogs were offered in evidence. Dyes did pass into the tonsils via the lymphatics. Moreover, Dr. Griffiths did not think the helpful results commonly attributed to tonsillectomy usually occurred as hopefully predicted. He found discharging ears and mastoid dis-ease in many of 5000 tonsil-less children. He held that many objectionable living

bacteria are routed to the tonsils to be excreted into the alimentary tract for destruction. Hence it appears probable that tonsils are of some use. They may not only perform regular lymphatic functions, but they have this special bacteria-destroying function also (such is this theory) because of their anatomical position. And, advertising to the contrary notwithstanding, it should be emphasized that germs swallowed are rapidly destroyed by the stomach acid and the intestinal juices. Infection via the oral route cannot so easily occur, nor is gargling a very effective preventive measure.

Despite all this mass of evidence, discarded teeth continue to rain into the dentist's garhage pail and discarded tonsils to make flames roar in the hospital incinerator.

What, then, may we conclude to be constructive with regard to tonsils?

An editorial in the Journal of Laboratory and Clinical Medicine for May, 1933, said essentially that doctors should not regard the discovery of infected tonsils as sufficient cause to neglect the rest of a complete physical examination. Bad tonsils are potential factors in producing generalized diseases and infections far from their site, but people should not be led to expect miracles from tonsillectomies.

The removal of tonsils does tend to decrease the recurrence of sore throat, but you can have sore throat without tonsils, and many do. Respiratory infections and most other ailments are about as frequent after as before the operation. Anyway, it takes about ten years fully to demonstrate benefit from the operation in case of serious ailments.

THE removal of tonsils under ether THE removal of which should be regarded as a major operation, always undertaken in the light of its possible hazards and never in the lack of complete justification. Laymen should stop shopping around among doctors, as so many of them do now, trying to persuade them to do an unnecessary tonsillectomy.

Undoubtedly the operation, when its need is properly indicated, can be very beneficial. It is frequently advisable in children but is rather rarely of real value to older people. It is doubtful whether the removal of a focus of infection has a particle of influence on dozens of diseases for which it is done. Practical help occurs oftenest in arthritis, but in case of older people this is too often like locking the barn 50 or 60 years after the horse was stolen.

A person having a lot of tonsillitis and sore throat gets definite benefit from the operation; a person with none gets none. That, according to one of the best informed doctors the writer knows, is the most important thing to remember in connection with tonsillectomy.



A MONTHLY DIGEST

THE SCREEN OF TELEVISION

THE heart of the television set, the Testeron' on which the image appears, as the rathodicary tube Within it is a mass of metals coated with similable chemicals which, when hearted, enti-electron particles are formed into a stream on heam by suitable chemicals.



Scaling-off a cathode-ray tube

tule and are projected to a Buonscent screen at the wide end of the rathorleray tule

Impunging of the electrons on the serven causes visible illumnation of the serven at the point of impact At any given instant there is only a single dot of high on the cathoderay serven. The beam sweeps across the serven at more than two miles a needing and serves to weave a television image. The cathoderay these now lenging produced for home television cinetiamment have a face, cathoderay these now lenging produced for dimater of 12 to 13 makes for the larger lengths, are could be produced and range in price from about \$35 for the small tubes to more than \$75 for the larger tubes.

Brearse of the high vaccious in validate by thise, there is a pressure over the entry thise, there is a pressure over the entre glass surface which mass into many tomes for the larger times. To withstand these trushing strain, the titles have glass walls areiaging about ½ of an indi-thek Alen, the titles are examined for weakness, prior to being need, in a device known as a polarisetope, which indicates the strength or weakures of any parts of the glass.

The elements of the cathode ray tide com-

Conducted by F. D. Mc H U G H

Contributing Editors

ALEXANDER KLEMIN

In charge, Daniel Guggenheim School
of Aeronautics, New York University

D. H. KILLEFFER Chemical Engineer

prise an intricate assembly of nickel cylinders, doffering plates, and a cathod. The cylinders serve to accelerate the electrons and to foun them into a sharp electron beam, to focus the beam on the fluorescent screen, and to increase or decrease the intensity

of the beam The assembly of metal and glass parts is mounted in a funnel shaped glass envelope and scaled in place, as shown on our front cover A glass tube permits pinning the air out of the glass envelope, this operation taking over two hours for the larger tubes While the pumping operation is being con ducted, the glass envelope is baked in an oven, which is part of the exhaust equipment, at a temperature of approximately 750 degrees, Fahrenhen. This baking drives off mosture which might otherwise remain inside the tube. Another precaution taken to climinate undesirable gases in the evacu ated tube is a bombardment of the metal parts, accomplished by slipping heavy coils, carrying high frequency current, about the neck of the cathode-ray tube, so that the metal parts are heated to incandescence through high frequency induction

The construction and assembly of the callude-ray tibe calls for exceptional accuracy in positioning and spacing the paris, since such details affect the quality of fursibel tibes. Also, the metal parts must be inhedded in the glass, which calls for great skill on the part of workers familiar with glass working.

MAKE-UP IN DEFENSE

IURID-WHITE "cosmetics" are used by some oil-well and petroleum-pipe-line workers. The oil-workers' facial adorament, however, is put on for defense

Petroleum geologists have discovered many oil fields beneath the waters of the Gulf of Mexico off the shores of Louisiana and Texas. Building a derick foundation under these difficult conditions made it necessary to us, crossored, water resistant timbers. One working on and around these timbers soon found that they caused painful facial inflamination and lurins. Pipedim workers, conting paper with a black water and corrision resistant, had the same trouble.

To protect themselves, they now danb their faces bliefally with a zine oxide preparation that gives them a bizarre appearance but says blisters and infectious

SMALL ARC WEIDER

A SMALL motor generator type are weld re, said to provide greater convenience and accuracy in welding because of a new self-indeating dual continuous current control, has been announced by The Lincoln

Electric Company Becames of its advanced features and moderate price, this unit is expected to within the application of welding in new fields such as garages, line and truck flert pairs sloops, sheet metal shops, maintenance departments of miph and paper mills, paint mills, cament plants, textile plants, gaplants, and smilar plants, as well as metal.

falurating shops, piping work, and so on The webler, known as the "A-150," hasboth job selector and current control calibrated and equipped with dials which in dicate the type of work and number of amperes for each and every setting. It is



For accuracy in welding

claimed that the development enables the welding operator to secure highest quality welds and highest possible welding speeds because he can vary both the slope of the volt-ampere crive and the amount of welding current independently and positively to sut every job encountered.

The unit is powered with a "Line-Weld," squirrel-eage, induction type moter for across-the-line starting. Connections are readily accessible for either 220 or 440 volts, 3 or 2-phase, 60 or 50 cycles as deared, the machine can be supplied for 550 volts or special voltages. Its current range is from 55 to 200 amorers.

SULFURIC

AIR and water, coming in contact with iron pyrites in roal mines, forms sulfurle acid amounting to about 2.802,000 tous per year, estimates the U.S. Public Health Service Sunce this water flows outward and pollutes streams, abandoned mines are being sealed up as fast as possible.

Engineering Costs

REDUCED

THE tremendous force excited by the extranson of concrete with the heat of the sim does costly damage to eiths and payments and presents a scrious problem to the engineers responsible for the establishment and maintenance of the moniments marking the lines of our enty streets.

An accompanying photograph is a view looking down into a manhole in the street and shows how the expanding pseement has moved toward the left, carrying with it the seast iron run that supports the manhole cover, and crushing the upper course of hereks

It frequently happens that the place for the engineer's monument at the intersection of the center lines of the streets coincides



Even though the pavement moves, reference points of this type remain effective

with what is also the desirable place for a manhole and the likelihood of movement of points set on a manhole cover or in the pavement is well illustrated.

The instability of a ference pounts in the other and with a fit which of the street is shown in a second photograph. The arrow underset the bend of a spake set in the earth at a catch basin to serve both as a reference pourt and look mank lutder pressure of expansion the curb has shifted more than arish to the right, shearing off the wall of the catch hasin, and has raised up nearly that are inches pointing the value of the spake both as a reference point and as a hench mark.

By an original method of ntilizing the brick structure of existing manholes, below the pavement, the engineers of the Los Angeles Bureau of Engineering have reduced the cost of maintenance and at the same time increased the stability of the system of points marking the street lines.

Four holes are d'rulled in the manhole wall and lead plings driven into them. Brass hooks are then serewed into the lead plugs in such a position that strings stretched between opposite hooks as shown in the illustration will intersect at the intersection of the street lines.

In practice, the manhole cover is lifted and strings or long rubber bands placed on the looks and the point of intersection used

as if it were on the surface.

Painting the hooks with liquid asphalt protects them from corrosion by gases that may be present in the manhole.—Edwin L. Stocking

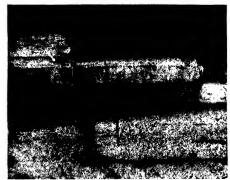
OXYGEN PRESERVES MILK

A NEW method of preserving liquid milk and nulk products, reported from Germany, consists of holding the milk at low temperature under oxygen pressure -- D, H K.

ACID-RESISTANT BOTTLE CLOSURE

THEIR aud-resisant transparent closure. Thas won for Merch & Company, Inc., hours in the Closure Group of the 1938 All-America Package Competition, sponsored by Vodern Packagen Magazine. This same closure also was selected for second award in the Scentific Group of the Third Annual Modern Plastics Competition, conducted by Modern Plastics Magazine.

This prize-winner utilizes an amber transpart polygon-shaped plastic cap, with a liner of impregnated glass cloth. The polystyrene cap is unaffected by the acid contents, and is always casy to remove and safe from leakage or breakage. It is used on an amber "Pour-Clean" bottle, which is named from the special pouring lip which is an in-



A serious problem for engineers: Expansion has moved a curb reference point

tegral part of the bottle opening and is covered by the acid-resistant closure

The prize-winning closure was molded by the Mack Molding Company from Bakeltic Polystyrene material, supplied by the Bakelite Corporation. The glass cloth for the cap liner is supplied by Owens Corning Fibrglas Corporation; the amber buttle by Anchor-Hocking Glass Corporation.

EXPANSION

BY high pressure hydrogenation, one and one fifth gallom of gasoline is being obtained in the United States from one gallon of oil. This is the highest yield yet attained by any process of treating petroleum.

PRE-TESTING THE AIRPLANE POWER PLANT

PLICHT testing a lugge flying hoat or a large landplane is a trieneadously expensive undertaking because of the powerful engines and the large crews required. Anything that can be done on the ground to shorten the flight tests is highly destable, and the Glenn L. Marrin Company has developed an engine test rigo to adview such an odd of the companies of the companies of the companies of the companies of the subble to determine the operating characteristics of the power plant months in advance of the trial flight.

The rig consust of a turntable on which is mounted a "mockup" of a proton of the arplane embracing a section of a wing and an engine in its nacelle. In the "observers' baleony" (to the right), located on a level with the engine, but shielded from it by a wall, are the instruments for recording temperature and pressure conditions throughout the fuel, oil, and cooling systems Our photograph has shown an elaborate portable rig for vibration study, which is an important part of power-plant tudy. The

propeller is, of course, included in the setup. The turntable makes testing possible with wind from various directions.

The use of the new rig speeds up delivery of a new model by as much as two months, reduces the hours needed for test flying by one third to one half, and fully justifies the somewhat heavy expense of building such a test installation.—A.

FLASHLIGHT PHOTOS 9000 FEET UNDER WATER

An appearus able to make flashlight picture 9000 feet heneath the surface of the water is the invention of Dr. Hofmann, as leading engineer of Munch. It is a deep-sea camera with which he has already conducted successful experiments in the depth-of Bodenee, or the Lake of Constance, as it is known to many American tourists. This invention as shortly to be subjected to further tests, this time 9000 feet below the level of the Tyrthenian Sea between Sardinia and the Inthus manufacture.

In recent times divers have penetrated farther and father into the depths of the ocean but after they reach a certain depth, the pre-sure of the water is so great that the stoutest diving suits are unable to offer resistance. Dr. Hofman's deep-sea camera have the advantage that no human being needs to accompany it not the ocean depths. It consists of a chamber nearly 18 inches in diameter, weighing rather more than a hindren properties of the properties of t

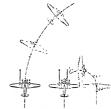
Increasing Flying Boat Maneuverability on the

WATER

ONLY small seaplanes have water rudders. The large flying boats have none, and the air rudder has but little effect when the flying boat is moving slowly on the

water. The maneuverability under such conditions is therefore very poor. To increase this maneuverability when using the present type of non-reversible pitch propellers, the pilot who wishes to turn to the right idles three engines of the four, and lets the left outboard engine pull him around. The turn is executed slowly and requires a great deal of room.

With the Curtiss electrically controlled propeller, it is now possible to reverse the pitch of the blades When the pitch is reversed, so is the thrust. The turn can then



Turning radii of flying boat on water with conventional propellers (left) and with reversible propellers

be executed much more rapidly, as indicated in the diagram, in which the arrows indicate the direction and relative magnitude of the thrust. It is obvious that, with appropriate reversal of pitch, a powerful turning movement can be applied. The pitch reversibility may also be employed in shortening the length of the run after algitum.—4. K.

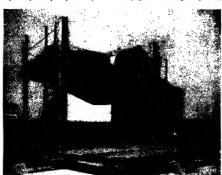
SAFE AIRPLANES

TENTATIVE specifications for private airplanes, intended to secure greater safety, have been susted by the Cuil Acronauties Authority. If these specifications—which are only tentative—are met, the Authority will allow the present dual instruction and solo flying time to be reduced appreciably in obtaining a nyate, pilot securificate.

obtaining a private pilot's certificate.
The sads history of the \$700 "diverve" airplane has made the industry a trifle skeptical
the new specifications. Airipace builders
say that their small craft are already reasonally safe, that aftery is a matter of care in
flying, and that radical changes in design
construction are say to defeat the very
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following quotation from the specifications:

*Landing and Taxying; (1) The simplane
shall be capable of being landed easily at
any speed between the minimum and at least
twee the minimum and shall tend to remain
on the ground after contact. (2) Fall application of brakes up to the point of skiddings
the tires throughout the entire landing run
shall be possible with no danger of nosing
over. (3) The landing gare shall be stable
in taxying and entirely free from ground
looping tendencies. The sirplane shall be



Airplane power plants are effectively pre-flight tested in this rie

easily accerable. (4) The airplane shall be capable of being landed over a 50-foot obstacle in a straight glide with no wind and brought to a stop within a horizontal distance of 500 feet. (5) The landing gers shall (a) landings having a vertical component of the velocity of 15 feet per second, and (b) straight glides to the ground in still air with the elevator control fall back, without overstressing any part of the airplane. (6) The airplane shall be able to tax in any direction and under complete control in winds up to 30 ms.h."

We believe that these requirements can be readily met by the use of the front nose wheel or "trucycle" landing gear; by bold use of flaps or air brakes; and by designing the shock absorber with a large travel and powerful shock absorbing qualities.

Other requirements call for adulity under varied conditions, impossibility of spinning under any conditions, and the provision of only two air controls, one governing the longitudinal attitude and the other for turning, both operated from the same control column.

Here we disagree with the spreifications of a surplane should be difficult to spin, but it is inconcrivable that it should never spin and a machine which cannot be epin voluntarily may also be hard to get out of the pin. Again, we do not believe that it is so difficult to learn to fly with three controls as to justify a surplement of the pin of the p

But it would be a great boon if the following "Minimum Field of View" were really made available to the pilot:

"The arplane while standing or taxying on level ground shall permit the plot an unobstructed level view straight ahead and through a lateral sweep of approximately 90 degrees to each side without moving from a natural comfortable position, and by reasonable movement the plot shall be able to see the ground within 20 feet ahead of the airplane."

With an inverted engine of narrow proportions, or a pusher machine, or just good design and plenty of window area, we think that our designers can come very close to securing this degree of vision.—A K.

MEASURING HORSEPOWER

IN arline operation, as much payload as possible must be carried on fast schedule, with the smallest fulc expenditure, and with the least wear on the engine. To check the two last items, the operator should have, at all times during a flight, an accurate record of the power developed by the engine. A number of ways exist for estimation



Diagram of a flying torque meter for measuring horsepower in flight



Stearman attack bomber, representative of advanced military practice

ing the power, but none of them is completely accurate. Mr. W. G. Lundquist, of the Wright A-ronautical Campany, in a paper presented before the Society of Automotive Engineers, advocates the use of a torque meter for this purpose. With such a meter, the power developed by the engine in fight can be determined with almost as much accuracy as in a test laboratory on the ground.

An example of the firms torque never An example of the firms torque never and the second of the

The use of a torque meter is but one example of the means which transport companies employ to check their operations

—A. K.

AIR CORPS EXPANSION

O UR readers are no doubt familiar, in general, with the program of Army Ar Corps. By July, 1941, the Ar Corps is to have a fighting force of 5500 to 6000 arthough a control of the property
In reading the various announcements, one is impressed first of all by the multiplicity of types available. Even towards the end of the World War, training, single-seater pursuit, day bomber, and heavy night bomber practically completed the classification. Now, further experience in various small wars, and careful testical attides, have led to a multiplicity of types, each adapted to one, or at most two, specialized purposes—four-engined flying fortresses, heavy bombers, single-engined pursuit, twin-en-

gined pursuits having speeds in the neighborhood of 400 miles an hour, troop carrying machines, interceptors to stop enemy bombers, multi-place fighters, and so on.

Both military designers and Corps tacticians are as a rule suspicious of airplanes which are to serve more than strictly limited purposes, because it has been found in the past that "all-purpose" machines serve all purposes badly. The construction of an "attack-homber" seems legitimate, however, for combining the high speed and powerful machine gun fire of the attack plane with the bomb equipment of a light bomber is logical enough. One of our photographs shows an attack bomber, the Stearman X-100, recently submitted in a competition in which North American and Glenn L. Martin were also among the participants. The X-100 is undoubtedly representative of the very latest practice. It is powered with two 1400-horsepower Pratt & Whitney R-2180 engines, the gross weight is approximately nine tons, the wing span is 65 feet, and the length is 52 feet. There is a crew of four to take care of navigation and machine gun and bomb compment. A feature of the new plane is the extreme vision afforded by the transparent panels which make up the entire forward portion. Since ar absolutely mooth skin is imperative at high speeds, flush type rivets are used over the entire surface of wings and body. In the design of the machine, an attempt has also been made to combine the ultimate in streamlining with the demands of rapid, large-scale production .- A. K.

STRAW FOR FUEL

RUSSIAN tests of straw as fuel in gas producers have yielded one kilowatt hour by burning three kilograms of straw. —D. H. K.

MACHINE CALCULATES TIMBER VOLUME IN FIVE SECONDS

A MACHINE which in five seconds gives the exact volume of a growing tree of any kind and any dimensions, and two other interesting instruments for timber assessments, have been built by a Swedish in-

The "trunk volume calculator," as the machine is called, has been constructed by a Swedish forestry technical expert, Capt. Alvar Drangel of Stockholm, and It has been



considered of such value that the Swedish government has helped finance manufacture and exploitation, It is a "nomo-mechanical calculating machine, equipped with certain mechanical devices through which a number of scales can be set in relation to cach other The machine is, practically speaking, an endless table system, which in five seconds solves an equation after five of its variables have been given exact values. For assessment of the cubic content of growing trees, the machine is thus set for the values of the trunk curvature, the class of bark, the taper percentage, the length of the trunk and, bually, the diameter of the tree at breast beight. The volume is then immediately obtained, exact to a ten thousandth of a rubic meter The machine, which has about the shape of an ordinary calculating machine, but is operated by dials instead of keys, is able to deliver no less than 8,000,000 volume figures

The two other instruments, constructed by the same inventor, are a "trink diameter registrator," working on the same principles as the first-mentioned machine and of about the same type, and a precision height measuring instrument, by means of which the height from the cut to any desired point on the trunk can be rapidly and correctly fixed The trunk diameter registrator is used for pre-calculation of the quantity of usable timher that can be obtained from a tree By means of it can be exactly fixed the top diameter in eighths of an meli within bark at a certain length from the cut or, the reverse, the log length at a certain desired top diameter - Holger Lundbergh

WORLD'S BEST LIGHTED FIELD FOR NIGHT BASEBALL

WHEN Comme Mack's Athletics and the Cleveland Indians inaugurated night baseball for the American League at Shibe Park, Philadelphia, on May 16, they played

on the best lighted sports field in the world Comprising 780 Westinghouse floodlights of 1500-wait capacity each, the new two-billou beam-candlepower lighting installation is of sufficient intensity to light a street 160

Two-billion candlepower makes this ball field the best lighted in the world. Below. One of the 1500-



inites long as brilliantly as Philadelphia s famous Broad Street; to provide light for more than 2000 homes, to make newspapers readable 175 miles from the light source, if the Boodlights were all concentrated in a single unit

"The Shibe Park infield is 20 times brighter than the average well-lighted office," actording to John Kilpatrick, lighting engineer. "It is several hundred times brighter than New York's Times Square on New Year's Eve."

There is no glare and resulting eyestrain for either spectators or players, Mr. Kilpatrick reported. This is due to the design of the floodlights and the unusual height at which they are placed. Too rows of lights in eight steel towers surrounding the park are 155 feet above the ground.

Six towers support targets on which are mounted 110 of the big 20-inch floodlights in 10 nerzontal rows of 11 lights each. Two others support 60 floodlights in five horizontal rows each contaming 12 lights.

Club officials announce that seven night

games will be played at Shibe Park this season by the Athletics, and seven by the Phillies It is also expected that the park will be used for night football games this fall.

MEASURING 2/100,000 OF

A MILLIMETER

A REMARKABLE measuring instrument, known as the "Microkator," which is capable of registering measurements down to 2/100,000 of a millimeter, has been invented by Hugo Abramson, Swedish engineer.

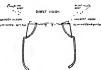
The principle applies a fretionless gear up to measuring instruments, and is remarkably simple. Its unit comprises, in the man, a thin strip of phospho-bronne, tweeted around its own hongrindinal aris, half arise to the strip of the strip

The inventor of this instrument, which is manufactured by the Swedish manufactured on the well known Johanson gage block and precision measuring instruments, the C. E. Johanson Company, of Edidstria, also has a number of other inventors in the precision measuring line to his studie, as a basic as a number of other inventors in the precision measuring line to his studie, as to example, the heatt heat indicator constructed by himself and his healther, Mr Abramon also has received the Gold Medal of the Swedish Academy for Engineering Research—Hidge Lindburgh

VISION CONCENTRATORS

The almost naturative for a pressure on extra me occasions to one his hands about his eyes the lietter to concentrate his vision in some scine or work before him. There is a debute principle involved in this action Eliminating inferret vision—or wide-angle vision—gives what is retinically called "ental fination"—secentially. Yimined vision." In specific seeing tasks, this is advantageous or, since objects in the periphery are abut vicinity in the contraction of the contraction of the which the attention is founded.

A simple device to attain this advantage has been developed by Frederick Saunders



and is being manufactured by the Columbia Protektosite Company. The invention came about as the result of Mr. Saunders' experimental use of two rolled-up programs at a moving picture show. Viewing the screen with them at his eyes started Mr. Saunders on a long study which resulted in the device called Concentrators. They literally congen-



A strikung example of a multiple electric motor installation. Not just one large motor or several smaller ones, but scores of individual units drive the many rolls on this run-out table at the new Sparrows Point. Maryland, bottstrip mill of the Bethichem Steel Company, Westinghouse made all the electrical equipment of this plant which turns out up to 2000 linear feet per minute of strip steel during long runs of tonings.

trate the sight and thus enable the user to concentrate more efficiently mentally

Concentrators look somewhat like ordinary spectacles, but they differ in having no lenses -unless the user needs sight correcting lenses-and in their patented features. To the outer eircumference of each eye piece there is molded a small opaque rim flange which projects forward and cuts down th angle of vision from side to side Projecting backward from the same rims, are shields which cut off all side light. The result is that all distracting side vision is completely eliminated. The effect is so marked that Dr Martin Grabau, former Harvard Uni versity physics professor, after testing and approving Concentrators, remarked that it was amazing how much could be accomplished so simply

phished so simply
Concentrators will be useful for students, stenographers, golfers and other sportsmen, theater-goers, and all those who must concentrate on work in hand.

GROWING TOBACCO WITH-

REPORTS from Italy state that tobacco leaves grafted on tomato plants grow with a total disappearance of necotine Leaves normally containing 2 to 2.5 percent income were used in the experiments and lost all their necotine content without having it appear in the leaves of the plant to which the graft was made—D. H. K.

"PULLMAN" FOR

TRUCKS are built these days to perform most any transportation job you care to name, but few are designed for a purpose as unusual as a fleet of eight recently ordered by the U. S. Bureau of Reclamation.

These are to carry thousands of giant salmon, 30, 40, or 50 at a time, alive and undamaged, to destinations they never would reach manded The fish will travel in 1000 gallons of Columbia River water, constantly acracted to supply the occupants with adequate oxygen, protected by insulation against conside temperatures ranging from 108 degrees down to 30 In trainst, the salmon compartment will be cooled gradually to prepare the occupants for the chill waters of Wenatcher River and Irclec Creek, Cracked ree, weighing 1800 pounds, is carried in a special compariment for this purpose.

Extraordinary precautions are being taken to keep the motoring side comfortable and unhurt. Every inside contour of the tanks is to be smoothed, and they are designed so as to fill to the brims, since the salmon must not be langed against the sides y slocking water. Specifications demand a 50-mile top speed with a gross lead of 25,000 pounds.
The job is an important one, affecting the luture of a great industry.

Up the Columbia River each year moves the greatest salmon run in the world, some three million fish, Chinook and Steelhead, bound for the headwaters to spawn and start the life of a new generation. The parent fish die but tiny yonigsters go down to the ocean to grow. Five years later, averaging 22 to 30 pounds apiece, these splendid salmon retrace their way upstream to their native waters.

A \$15,000,000 a year industry depends upon the continuance of this vast migration,
but its way now is disputed by power dame
built to harness the vast energy of the turbulent hurrying river. Millions have been
spent to build fish ladders to get them past
Bonneville Dam, but at Grand Coulee, 450
miles from the sea, the way is blocked.

The task given the eight fish "limousines" is to collect the asimon whose insute heads them to the streams above Grand Coulee, and carry them to other, sublocked inthiataries. It will not be an easy job From July to the end of September, the run will be at its peak, and fish trucks will have to be on the orall tile time employing the fish of the country of the cou

ENZYMES

SOME of the enzymes present in beef, are; peptase, arginase, trepa-tase, ureae, erreptase, hippuricase, deamidase, sulicase, helicase, nucleuse, aldelydase, peroxidase, nitrase, lipase, lectihase, amylase, malase, glycapenne, sucrase, glycolase, arbutase, phosphotase, catalase, salduse

Some?

ALCOHOL ANTISEPTIC FOR WAR-WOUNDED

HOW warstorn Spain became the proving ground for a new type of alcohol anti-sepite vs revealed for the first time in Midstery Surgeon, official publication of the U.S. Association of Military Surgeon. Adding weight to the report is the fact that its author, Major S, Penez-Vasquez, M.D., was physician in charge of the famous Hospital de Carabineros in Madrid.

The new alcohol antiseptic which Dr. Perez-Va-quez found to be the "most satisfactory of any preparation in general use" may have even wider application in peace. He writes that, on war wounds of all types,



Special truck designed to carry giant salmon, alive

it not only controlled infection with less discomfort to the patient, but also speeded healing and shortened the period of hospitalization

"Even when . . . used several hours after injury, a quick drop in fever is observed, and within four days after beginning treatment, healthy granulation tissue appears. Much less operative surgery was required."

The new antiseptic—a mixture of ethyl alcohol, glycerine, thymol, phenol, and camphor—was evolved by Dr. Perez-Vasquez and liss associates in an effort to find a solution which could be used with simple irrigation in place of the cumbersome technique and specialized apparatus of the Carrell-Dakin method.

It was perfected, Dr. Perez-Vasquez states, after a careful trial of other approved and generally used antiseptics including rodine

and several proprietary products

The article in the Multary Surgeon gives
the formula and directions for compounding
the solution

A PROFESSOR'S SCIENTIFIC PIPE

WHEN science invades the sauctity of man's popular pastime of pipe smoking, the result is a highly-engineered job which offers convenience and satisfaction to the smoker. Latest evidence of this fact is



the scientifically-designed pipe invented and perfected by F. K. Kirsten, professor in the school of Aeronautical Engineering at the University of Washington.

An enthusastic pipe smoker himself, Prof Kirsten set about to apply engineering principles in developing a pipe that would elimmate the objectional features ordinarily associated with pipe smoking.

The Kristen pipe in based upon effective cooling of the molecular bounds on the undersuble oils and tare, which are in volatile form, are removed by condensation before creating the smoker's mouth. To obtain efficient cooling, a unique stem, or barrel, is used it is made of alumnium alloy and has a characteristic high their conductivity supplemented by an efficient flutted design which increases the rate of heat dissupation.

In order to allow ample time for the amoke to cool completely, the volume of the radiator has been precisely determined so that it holds the equivalent of the average smoker's puff, or from six to twelve cube centimeters. Because of the radiator's volume, the gases can remain in it for the duration of and the interval between puffs. Experiment has shown that this period is long enough for the commentations of the commentation of the commentat

plete cooling of the smoke and to permit the undesirable contents to condense.

The condensed tars and water vapor coler in a small radiust cap, also of aluminum alloy, at the lower end of the barrel—the lowest point of the pipe when in the smoking position. Their flow back into the bowl is prevented by a valve mechansum which is incorporated in the radiator cap. By giving the cap a right angle turn, the valve closes the bowl outlet, and the pipe can be turned to the bowl coulet, and the pipe can be turned to the cap are part to the bowl coulet, and the pipe can be turned to the cape a right cape to the couple to the cape and the cape and the cape and the cape to th



Left: The scientifically designed pipe has an aluminum stem. Abore: Each part of the pipe is designed to accurate engineering specifications. Parts are interchangeable. Right: The same principles have been applied to a cigarette holder

and none of its odors can escape. The radiator cap can readily be removed to empty the condensates.

The bowl of the Kirsten pipe is detachable, being held in place by a double-builted aluminum alloy screw which forms the bottom of the bowl. The farme permats the smoker to meterchange the bowl with any one of a sarrely of stuck shapes and size available. The mner walls of the bowl are alonged to give the most efficient combustion of the to-bacco, it was found that the most uniform burning was reflected by shaping the sales of the bowl so that they formed an angle of 38 degrees with the vertical.

An alumnum ramrod is attached to the make tube fitted in the mouthpiece and serves as an aid in cleaning the pipe by running a piece of tissue paper through the radiator, an action not unlike cleaning the

barrel of a gun.

The pipe is 10 to 50 percent lighter than the conventional design pipes.

The scientific principles of the Kirsten pipe have been carried a step further in the Kirsten cigarette holder which also cools (and cleans) the smoke through radiation from a finned aluminum alloy stem.

DIPHENYL SAVES PALES-TINE'S CITRUS INDUSTRY

I ONG distance shipping of Palestine's Lacitrus fruit crop is made possible by wrapping it in impregnated paper. Losses by spoilage are reduced by this method to

approximately 10 percent of their former value. Diphenyl is used to impregnate the wrapping paper and this in no way affects the odor, taste, or appearance of the fruit. This method may save the citrus fruit industry of Palestine by permitting the economical export of its product to remote markets in north Europe.—D. H. K.

SELF-ADHESIVE LABELS

SELF-ADHESIVE labels, manufactured by Avery Adhesives, coated on one side with a non-drying gum, will adhere to any smooth, hard surface without leaving any stain or gummy residue no matter how long they are in place. These Kum Klean labels can be used for marking glassware, silver, office supplies, pottery, china, toys, furniture, and other merchandise.

INSECTS versus WEEDS

A TINY Argentine moth has saved a training from being turned into desert by a predaction plant which was devouring more than 1000 acres a year, literally driving farmers out of their houses, and resisting attacks with liquid fire. The plant is the pricky pear, a species of certus common over the United States, Micros, and South America, and which is often grown as an ornamental in gardens.

Nearly a half century ago a few plants were introduced into Australia from North America, intended for flower gardens. The prickly pears found themselves in an earthly paradise where they could run wild will nothing to stop them. By 1925, they had



covered more than 60,000,000 acres in Ouernsland and New South Wales. Most of this had been good grazing and farming land. About balf of it was in the grip of a dense jungle of actuals from three to five feet high and so thick that it was impenetrable. The other half was covered by less dense growth, but was rendered nearly useless for sarreduter.

Just when the problem seemed unsolvable, salvation came in the form of the little Argentine moth. Australian entomologists had hunted all over the Americas for insects which might help get rid of the cactus. Many type specimens were studied in the collections of the Smithsonian Institution. The majority of them, it was found, did we real good. Their larvae ate the cactus, but the

plant was too tough to be killed by them. The Argentine moth, however, displayed life habits which admirably fitted it to rescue a continent.

The Australian entomologius tell of one stretch in Southwest Queensland where the prickly pear extended in a dense, almost continuous belief for 100 miles. A noth colony was planted in this neighborhood. A year later the entomologists were in despair. The niscets seemed to have done no good whatsower. Dut another 12 months and the whole jungle had simply collapsed. At least 90 per continuous productions of the production o

SULFANILAMIDE FOR SMALLPOX?

THE new drug sulfanilamide appears to have value in treating smallpox. Four cases in which it largely preented the eruption from the disease are reported in the Journal of the American Medical Association by Dr. Walter O. McCammon of Springfield, Kentucky.

Seven cases of smallpox recently came under the observation of Dr. McCammon He
used sulfamiliamde in treating four, and
there was only a slight cruption which soon
diasppeared. The patients were back at work
a week sooner than were the other three
cases which were treated symptomatically
and in which the typical cruption of smallpox
develoned.

In an editorial, the medical journal points out that no conclusions as to the value of sulfanilamide in preventing deaths from smallpox can be drawn from such a small number of cases

Although smallpox is increasing (there were 14,355 cases reported last year) the disease is now mild —Science Service

SEED GERMINATION WITH

NATURE'S way with seeds has always been hard to figure out—a hit-and-miss proposition largely based on guesswork. But the Peppard and the Rudy-Patrick Seed Companies of Kansas City, Missouri, have

Below: The air-conditioned unit for seed germination and, right, shelves on which seeds are placed





Gold in an automobile factory may seem incongruous, yet in the Rouse plant of the Ford More Car Company it does a "bloover," but of expediting the drying of enamels with which motor-eer parts are factored. (See a Cartelling the drying of enamels with which motor-eer parts are food. (See the control of the May, 1939, page 225.) This striking photograph shows one of the tunnels through which bodies are drawn, after painting, to be dried rapidly by the infrared rays from a battery of lamps. These lamps are backed by reflectors, the surfaces of which are gold plated, since it has been found that such a surface most efficiently concentrates the desired rays on the automobile body.

eliminated the guesswork and reduced the whole process to a science. They employ the use of seed germination boxes to test the growing ability of all varieties of field grasses and garden seed. In this way, Mother Nature's future whims are accurately prognosticated.

A given number of seeds from any one lot is placed on moist blotting paper and inserted in the germinating box. Within the box, it is imperative to hold the relative humidity at 90 percent and to maintain tem-



peratures which correspond as nearly as possible to the temperatures to which the seeds would be exposed in the fields during their planting or sprouting period. This temperature, of course, varies during the 24-hour daily cycle. Therefore, in the germinator, varying temperatures are maintained—name ly 68 degrees for 16 hours simulating the night, and 85 degrees during the eight hours

erresponding to the aunlight cycle.

Of course, there are aceds which must be

planted the first thing in the spring, such as radules, lettuce, alfalfs, and clovers. These do not require as much heat to protut and, therefore, are placed in one compartment of the compartment of 86 degrees. It is for the reason that each germandor is constructed with two compartment—one equipped only with refrigeration and the other with both refrigeration and an electric airly heater.

The Creamery Package Manufacturing Company of Chicago, through its Kansas City office, furnished these Trane germinatlag units.

INDUSTRIAL USE OF

PAPAIN

ROM 1932 to 1938 the United States unported crude papans increased approximately four-fold to 223,000 pounds. This mately four-fold to 223,000 pounds. This mately four-fold to 223,000 pounds. This from the skin of the unrape pagay, which from the skin of the unrape pagay, which represents the state of t

NON-SHOCK TREATMENT FOR MENTAL DISEASE

M ENTALLY sick patients are now being by the simple and comparatively safe measure of breathing nitrogen, it was announced at a recent meeting of the Federation of American Societies for Experimental Biol-

"Encouraging results" of this new, non-

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shock treatment for insanity in a small series of cases were reported by Drs. H. E. Him-wich, F. A. D. Alexander, Basile Lipetz, and J. F. Fazekas, of Albany, New York, Medical College and Union University.

The new treatment achieves its effect by the same mechanism as the drastic insulin and metrazol shock treatments. This is by decreasing the metabolic activity of the brain. The nitrogen inhalation treatment, however, is easier to give than insulin shock and does not produce the fearful convulsions of metrazol treatments which are dreaded by both patients and physicians.

With the new treatment, patients breathe nitrogen long enough to deprive the brain of its oxygen supply for about five minutes These treatments are given three times a week for a period of about three months.

Cutting down the oxygen supply to the brain reduces its inetabolic activity. Metrazol does the same thing by temporarily ar resting breathing movements. Insulin shock does it by depleting the sugar supply to the brain, without which the brain cannot use orveen

The fact that metrazol and menhashock treatments both produced this effect of decreased metabolic activity was discovered a year ago by a University of Toronto research team under the leadership of Sir Frederick Banting and Dr & Edward Hall. At that time Dr. Hall predicted that neither insulin nor metrazol would be the last word in treat ment of schrophrenia and that a better and less severe remedy would be found to replace them The nitrogen inhalation treatment seems now to be that remedy ... Science Service

ALLMINUM IS SOURTED

AllONG the manufacturing operations performed on aliminium alloys, none is more interesting and speciacular than the impact extrusion process. By this method, a small be out-shaped slug of aluminum is transformed in the twinkling of an eye into a tooth paste tube, a flashlight case, or any one of several hundred commonplace containers and shapes

The moving head of an impact extrusion press is fitted with a punch or hammer which is slightly smaller in cross-sectional dimensions than the stationary die The slug of aluminum is placed on the die, the hammer strikes the slug, and the high pressure forces the aluminum slug to "flow" up past the clearance between die and hammer, thus forming a collapsible tube or any other shape determined by the die The metal is literally "squirted" into the desired shape.

Pieces and containers of various si shapes, and intricacy of design can be formed



A slug of aluminum is in the



The aluminum is squirted

extrusion process. Many parts ordinarily made by drawing, spinning, stamping or turning can be produced to advantage by this method. The chief advantages to be obtained by adopting this process are closed diamentonal tolerance, a high degree of uniformity in parts, and surprisingly low production costs.

By the nature of the impact extrusion process, the metal is strain-hardened, devel-



. . and a formed tube results

oping its strength and stiffness. Thermal freatment may be used to anneal the finished product for the softness necessary in collapsble tubes or the parts may be given even higher strength by controlled heat treatment. Thus, various properties are at the option of the designer

There are almost no limitations on the shapes of impact extrasions. Symmetrical and basically cylindrical forms are the bessured to this process, but square, outh, revtangular, and asymmetrical parts can be made rapidly and a low unit con. The wall blickness of parts can be varied from thirds with a point's of stress and strain to this natural light weight of aluminum is added the advantage of less griefs where on aerded

BEWARE! TICKS CARRY SPOTTED FEVER

CONSIDER all ticks dangerous, advises the U. S. Public Health Service, even though only one in 300 of the eight-legged pests is capable of transmitting spotted feeer, in the most heavily infected areas.

Although the exceedingly dangerous tickborne disease was first found in the west, whence its name of Rocky Mountain spotted fever, it is now known to exist eastward to the Atlanic, as far north as Massachusetts, and as far south as Georgia.

If you live where ticks abound, or if your dog brings them to the house after cruising in the brinsh, better examine yourself all over at least once a day off you find a tick has taken hold, remove him with a pair of

= casso =

WHERE SCIENCE ENDS HOSPITALITY BEGINS



The Waldorf, for example, is a magnificent scientific achievement, not only dependent on science when it was built, but continuously dependent on many sciences for the efficiency of its operation.

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neeng caretin not or was it. Ites yuce can be very dangerous.
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the General Electric Company. The units are in the low-price range and are particularly well suited for voltage surveys, complaint investigations, and elecking circuit load conditions. The inkless mechanism, which uses a typewriter tibbon to make the record by a series of dots, results in greater simplicity, mail size, and light weight. There is no inkwell to clean, no pen to start, and nothing to freeze in cold weather. A cast aluminum alloy case protects the mechanism and forwhile expended to the weather. Although they are portable, the new instruments may be wall or pole-comment.

FLAMEPROOF FABRICS

FACTORY PRECISION

DON'T believe it if someone tells you that E. E. Burger, shown in an accompanying illustration, is sightling his bow and arrow for a bull'scyc shot at a target. The bull'scyc at which he is "aiming" is the measurement of any difference between the



Determining expansion coefficients

expansion coefficients of metal and glass. In the manufacture of vacuum tubes, insulators, and other electrical products, metal and glass must be sealed together to withstand varying temperatures, and it is through this tele-scopic "sight" that Mr. Burger determines expansions as small as ten milliontlis of an inch in the Research Laboratory of the General Electric Company

WELDED HACK SAW BLADES

HIGH efficiency is the claim of the Arm-strong-Blum Manufacturing Company for its Marvel high-speed-edge liack saw blades They are manufactured by uniting a high-speed steel tooth edge with a supporting body of chromium vanadium steel. The two parts are integrally welded by a patented electric welding process.

It is claimed that the high-speed steel edge provides all the fast-cutting and longwearing qualities of good cutting tools, while the body of chromium vanadium steel contributes exceptional strength.

ELECTROPLATING WITH A Review

SMALL repair shops and home workshops can now have their own electroplating equipment. An inexpensive kit recently put on the market by the Rapid Plating Process Inc., enables the shop or home user without previous experience to electroplate individual articles or worn spots on various ob-

The plating is done with a specially designed brush through which an electric current passes. Only one or two dry cells are required. The plating compound is of a jelly-like consistency and contains, in a highly concentrated form, the metal to be deposited This compound adheres to the surface being plated without spilling or running. Objects even in overhead positions may be plated without dismantling or loss of time from

It is claimed that the quality and permanency of the platings are equal to com-mercial platings, thickness for thickness. Nickel coatings of 1½ to 2 ten-thousandths can be successfully deposited with a com-



EVERY important discovery relating to mind power, sound thinking and cause and effect, as applied to self-advancement, was known centuries ago, before the masses could read and write. Much has been written about the wise men of old. A popular fallacy has it that their secrets of personal power and suc-cessful living were lost to the world. Knowledge of nature's laws, accumulat-

ed through the ages, is never lost. At times the great truths possessed by the sages were hidden from unacrupulous men in high places, but never destroyed. Why Were Their Secrets Closely Guarded?

Only recently, as time is measured; not Only recently, as time is measured; not more than twenty generations ago, less than 1/100th of 1% of the earth's people were thought capable of receiving basic knowledge about the laws of life, for it is an elementary truism that knowledge is power and that power cannot be entrusted to the ignorant and the unworthy.

Wisdom is not readily attainable by the general public; nor recognized when right within reach. The average person absorbs a multitude of details about things, but goes through life without ever knowing where and how to acquire mastery of the fundamentals of the inner mind—that mysterious allent compilies. mind—that mysterious allent something which "whispers" to you from within.

Fundamental Laws of Nature

Your habits, accomplianments and wear-nesses are the effects of causes. Your thoughts and actions are governed by fundamental laws. Example: The law of compensation is as fundamental as the laws of breathing, eating

and sleeping. All fixed laws of nature are as fascinating to study as they are vital to understand for success in life.

You can learn to find and follow every basic law of life. You can begin at any time to discover a whole new world of interesting truths. You can start at once interesting truths. You can start at once to awaken your inner powers of self-understanding a n d self-advancement. You can learn from one of the world's oldest institutions, first known in Amerlea in 1694. Enjoying the high regard of hundreds of leaders, thinkers and teachers, the order is known as the Rosicrucian Brotherhood. Its complete name is the "Ancient and Mystical Order Rosse Crucis," abbreviated by the initials "AMORC." The teachings of the Order are not sold, for it is not a commercial organization, nor is it a religious sect. It is a non-profit fraternity, a brotherhood in the true sense.

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Each \$1.50 postpaid in continental U. S. (\$2.00 postpaid elsewhere) For Sale by SCIENTIFIC AMERICAN, 24 West 40th Street, New York paratively few brush strokes. Cadmium 2 to 4 ten-thousandths and silver 1 to 10 tenthousandths can be deposited, depending upon the time expended in the operation. Other metals which can be plated by this method are gold, copper, tin, and zinc.

The process is not designed to replace the commercial method of electroplating but rather to supplement it. The brush method is particularly useful for miscellaneous small tohs and for touching up small areas which are not subject to heavy wear,

ICE

APPROXIMATELY 15 million tons of ire-enough to make 240 billion average-size cubes-are required annually by the American railroads to keep freight and passengers cool. The great bulk of ice purchased or manufactured by the railroads and refrigerator car companies-nearly 13 million tons of it -goes in what have become known as "America's rolling refrigerators.

SOUEAKING RUBBER

THE problem of the squeaking rubber mounted spring shackle is an annoying one for motorists. Oil should not he used as a lubricant because of possible softening of the rubber, and brake fluid affords, at best, only a temporary remedy A satisfactory lubricant is made of colloidal graphite in glycerin and water, reports B II Porter, of Acheson Colloid Corporation Glycerin has desirable characteristics as a rubber lubricant and it increases the retention of the graphite by the lubricated parts. The water acts as a carrier and soon evaporates.

CORN COB LIGNIN SOFTENS CITY WATER

N their search for some practical use for IN their scarch for some products lignin, one of the principal waste products of the country, chemists have discovered that recovered lignin is more effective in treating hard water containing iron than commercial compounds now in use.

At the Agricultural By-Products Laboratory, Ames, Iowa, chemists of the U. S. Department of Agriculture treated hard city water, hard well water, and water containing added iron with lignin prepared from corn cobs and found this material to be effective as an iron-removal agent.

Supplies of lignin are inexpensive because they are almost limitless. Roughly, one fourth of all wood plants, meluding trees, is ligmin. As a waste product of wood pulp mills, where its disposal pollutes streams, it amounts to about 1,500,000 dry-weight-tons each year. At least six million tons a year is available from corn stalks and an equal quantity from wheat straw. Other extensive supplies are cottonseed hulls and sugar cane bagasse-the fiber remaining after the juice has been squeezed from it

In treating water that contained about 36 parts per million of iron with 500 parts per million of lignin, the iron content was reduced to an average of about two tenths of one part per million. The lignin was recovered and used again up to 10 times with no appreciable lessening of efficiency. The same



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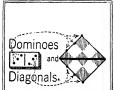
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amount of an inorganic compound commonly in use reduced an identical iron content to only one and one half parts per million for the first six times it was used and thereafter rapidly lost its ability to remove the iron. The cheaper lignin powder not only removes more iron, but can be recovered and used more times.

Many cities may find it possible to use the lignin treatment with existing water filtra-tion plants by adding the recovered lignin to the water in the mixing and sedimentation tanks, or applying it as the water enters the moval

REVOLVING MULTIPLE-SCALES FOR METERS

ON the measuring instruments of the present day with several measuring ranges, it is necessary to multiply the results by a given factor which has a different magmtude for each measuring range These calculations not only entail waste of time, but they are a source of possible errors, and this, of course, means that they may constitute an



Above: Flexible multiple scale for meters, Belou Several rows of numbers on a conventional meter scale



element of danger for apparatus through which current flows. The difficulties are peculiarly serious in the case of several scales with varying characteristics.

The elimination of all calculating work, when using electric measuring instruments, can be made possible by introducing suit-ably divided and numbered divisions into the scale-field for each measuring range; on the other hand, it must not be necessary that a measuring range represent a given multiple of another range. This problem has been solved by the Toroid Multiple Scale. A rope pull, or toothed-wheel, coupling between measuring-range selector and multiple scale effects a positive change-over of the scale, along with the change-over of the measuring range, with the result that all risk of con fusion is climinated.

One of our illustrations shows the construction of the new revolving multiple-scale. A flexible roller, preferably a seamless foldtube in spring-bronze, is arranged to revolve on an axle which is curved to correspond with the form of the scale as it must appear behind the window of the case. It is coupled



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with the measuring range selector which is constructed in the form of a rotary switch. Surrounding the flexible roller, an elastic sheathing in either cylindrical or prismatic form is firmly connected with the fold-tube, and on this the numerals or divisions are marked. Thanks to its unique construction, the fold-tube has been found quite torsionproof. It can be driven from one side, without twisting and there will, consequently, be no distortion of the divisions. The cylindrical revolving body is used when several rows of numerals must be interchangeable, while the prismatic form will be selected when not only numerals but also complete divisions must be changed

INVENTORS KEEP AFTER AUTO IMPROVEMENTS

NE in five of the 43,000 paients granted by the United States during 1938 had an automotive application

A total of 8268 of the patents granted re-lated to the motor vehicle in some fashion Not all affected the incchanical or exterior design of the car itself, many dealing with manufacture and repair, with parts, accessories, lubricants, fuels, as well as special machines and processes usable in car pro-

Of these, only 349 were assued to automobile manufacturing companies. The automo tive patents represented an increase of 1004 over the number granted in 1937, while the total volume of all patents granted was only 271 above the 1937 total

RUBBER PAINT

A PAINT containing a rubber hydro-carbon is said to be especially suitable for chemical laboratories because it is not only decorative but also resistant to acids, alkalies, fumes, and moisture, according to the Fisher Scientific Company Other claims are that the paint will not crack or peel at temperatures up to 350 degrees, Fahrenliest, and that it can be applied to wood, metal, plaster, concrete, or brick Plicote, as the paint is known, is available in ten colors and white

COMPOUNDED WOOD IS NEW MILLING ADVANCE

THE old practice of veneering furniture, which turned out a mahogany table for five dollars, is back in a new and much more fundamentally important form.

Compounding wood, as the process of veneering is known to the trade, is now turning to the new field of making wooden beams which have all the uniformity of characteristics of steel and other metals Do you wish a wood with a given density, a given elastic strength and other properties Compounded wood is the answer and each time you place an order with the mills it

Comes through the same, time after time.
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purposes becomes the core of the plank and laminated layers aupply the exterior. The proportions of each are varied so that the same characteristics can be repeated at will.

In part, the use of phenolic resins as the gluing agent in the finished board is the difference between older veneer panels and the new beams of technologic mill working. The various layers of wood are arranged in

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electrically, and hashly pressed at proper temperatures into finished lumber. "These boards," states the Industrial Bul-lein of Arthur D. Little, Inc., "meet pre-determined specifications, with widths pre-viously anavailable, and with a uniform adherence to specification comparable to that of the steel construction industry."

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"SCREW-SOCKET"

FLUORESCENT

THE accompanying photograph shows a new type of fluorescent lamp, which may be screwed into the conventional electrical socket without special installation or wiring, as completed by the Duro-Test Corporation. The new lamp will be marketed for commercial lighting as well as for certain types



The new fluorescent lamp, at top, and its hayonet-joint screw socket

of domestic illumination. It is estimated that all fluorescent lamps reduce current costs about 80 percent to give light equal that provided by the incandescent type of The tube itself, when it burns out. lamp can be detached from the starting device which forms the part which screws into the socket. In addition, Duro-Test's new fluorescent starting device uses only 212 waits

BIRDS OF PREY MAY CARRY RUBONIC PLAGUE

BI BONIC plague, like other forms of death in these days, has apparently taken to air travel. Not on the man-made wings of airplanes, but on the wings of hawks, owls, crows, and other predatory and scavenger birds, says the U. S. Public Health Service

The suggestion comes from William L. Jellison, assistant parasitologist at the Rocky Mountain Laboratory of the Service. Thirty years ago, Dr. W. C. Rucker made a similar suggestion, but limited it to one species of burrowing owl that shares habitations with ground squirrels and other rodents that car-ry fleas which are in turn the ultimate carners of the plague germs. Mr. Jellison, how-ever, greatly extends the list of suspected birds, to include two species of hawks, two of falcon, three of owl, and one species each

of eagle, magpic, and crow.

All these birds prey abundantly on the plague-carrying rodents. The scavengers, like crows, devour their catches on the spot, but predators, like hawks and owls, carry the carcasses to their nests, with the possibility of distributing the fleas either on the way or after they arrive, In several cases, these flesh-eating hirds were observed in attacks on rodents dead or dying of the plague.-Science Service.





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SIMPLIFY YOUR TABLE-TOPPING

THE art of table top photography is con-tomally stressed by photographic writers s being one of the simplest of camera endeavors. Frequently, however, these same writers debberately contraded themselves by introducing methods and illustrations not casely within the reach of the average amatero Nevertheless, table-topping is a sim-ple exercise when discussed from the point of vow of the anatour worker. The truth is that there is table topping and table-topping in its most elaborate form it calls for trained, professional craftsmanship, as, for example, the miniature settings designed and executed lor use in motion picture studios

But, for you and me, table-topping means mething clse again It means, actually, a clear space on a table upon which are ar ranged a number of simple odds and ends either found around the house, purchased in the five and-ten-cent stores, or id you are at all handy, made by yourself

Your principal difficulty will be in providing suitable figures. If you can make them yourself, so much the better, but most of us cannot However, the little non and other toy figures in the stores will regally do the trick admirably

Another feature of table top set-ups is the question of furniture Occasionally it is pos sible to pick up miniature reproductions of fornitite pieces but the best procedure is to make the formula yourself. This is not as deficult as it may sound Ordinary card board will often serve the purpose and a column may easily be simulated with a small cardboard mailing tube or even a sleet of paper twisted round and held together with a strip of adhesive. An excellent medium for miniature furniture-making is balsa wood, now obtamable in home custsman packages, comprising an assortment of



4bove: Making the set-up for "The Shadow of the Law," as described in the text and, below, the result



balsa wood in several thicknesses and

lengths.
"The Shadow of the Law" illustrates what can be done with a couple of tron figures to bought in the five-modern-ent store. These consisted of a policeman and a strolling pedestrian. The objective was to a trange in a simple manner a street scene showing a many opticeman, whose body cast a long shadow down the sidewalk, while a civilian approached him from the opposite direction.



Set-up for "Performance"

A piece of cardboard was wored with a perhanfe at one inch nitervals over a space about four inches wide, and a strip of black. Stocks hape separated this portion from the rest of the cardboard. Thus, when the light hearn was directed at the low angle noseary for the progression of the long-should research the properties of the provided the effect of separating grooves between the "stone slabs" of the sidewalk.

In order to complete the impression disired, no effort was made to continue any further in the matter of a set up other than to provide a black void beyond the sidewalk ofge. This was done by placing the cardboard on a black cloth and so arranging the light that very little of it reached this cloth. The spotlight used to illuminate the subject.



Huminated by the large candle to down left of figure. No other illumination was employed for this



"Darfamana"

was, therefore, cut down in heam size through the se of a price of cardibard in the center of which a hole was cut of a p proximately the damater required to bring about the desired limitation of the illimnated area in order to throw some light into the face of the poleceman a reflecting screen covered with silver foll was placed as shown. This caught some of the light, and, by satisfied angling of the screen, brought a little light onto the from of the brought a little light onto the from of the law been disk. With all the consequence of the consequence of the consequence considerably, the exposure was about 20 seconds.

Given an interesting figure, several variations are possible with different lighting arrangements. This is illustrated in the figure of the costumed dancer, which is another 10 cent purchase

Simulation of a stage performance by the dancing figure was accomplished by cinploying twelve tiny birthday caudles set up on two wooden blocks before a "stage" consisting of a hox covered with black cloth. For the background a sheet of hight-toned cardboard was used. The twelve candles were lighted quickly one after the other just before the exposure was made because these tiny candles burn away rather quickly To avoid including the lights in the field of view, as well as to prevent unwanted light reaching the lens and causing possible glare, the lighted candles were shielded from the lens with a cardboard blind. The presence of so many light sources caused a multiplicity of shadows to appear in the background but hecause one shadow was partially merged with the succeeding one and because of the large number of light sources, no one shadow was definitely apparent. If it is desired to show such a projected shadow, the best method is to use only one candle, a large one, placed to one side of the figure and at about the level of the small candles or even a bit higher, provided the flame is not included in the comers view

FIND OUT FOR YOURSELF

THE value of experimentation was recently demonstrated by Ivan Dmitri, the famous color photographer and one of the judges in the Scientific American annual photographic competitions. Mr. Dmitri, in a

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est improved type munature camera featuring exclusive rapid film transport, accurate shutter with species of 1/2 to 1/200th second, bulb and time. Agfa Mennar 18-5 anastigmat lens, direct-view finder, accessory clip, tripod socket, and neckoord Takes 28 pictures (17/16 x 15/18) on 35 mm film Camera complete, with 45 lens 28:500 Same camera with 15 5 lens 285 50

New Agfa f6.3 Clipper \$1550



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AGFA CAMERAS

public lecture in New York City in which he described his experiences in shooting color pictures with his Leica camera, declared that he learned the proper exposure time to give under various lighting circumstances by making a series of experimental shots over a period of time. From the rescribes as his basic exposure, namely, 1/6.3 at 1/60 of a second. Where a higher shutter speed is required he simply runs down the scale and opens the lens wider in proportion to the speed required to stop the action involved, using the stop f/15 and a shutter speed of 1/500 or 1/1000 of a second when necessary. Similarly, in the case of subjects that are a bit too dark for the basic exposure set up he opens his lens wider for the basic shutter speed

There is much to be said in favor of Mr. Dmitri's method and it would repay every worker to set up some similar basic ex-posure method whether he shoots in color or black and white, Mr. Dmitri says that he hardly ever uses an exposure meter because his exposures have become standardized by his personal method of working. However, it must be remembered that Mr. Dmitri shoots entirely in color, using 35mm Kodachrome exclusively. Having used this over a long period of time, he has become thoroughly familiar with the results he can expect under various circumstances For gen eral photography an exposure meter would seem to be one of the musts in the photographer's equipment; however, the worker must train himself not to rely absolutely on this guide to correct exposure, but to think for himself as well, and to interpret the readings rather than to follow them without question

One of the surest wars of acquiring the ability to make such interpretations is to about a number of different exposures of the same subject under the same lighting conditions and then compare the results. Pick out the negative that seems to you to or more than the actual meter reading, and just your meter calculations accordingly For example, if the meter said f/8 at 1/100 and your shot at J/11 seemed to give the better negative, all you will have to do therester will be to take one stop amulier than the moter decases, adjust the shutter to Weston rating for your film.

COLOR DEPARTMENT

RECOGNIZING the wide interest in color in supplies and information as unterested and to bring greater demands for supplies and information as unte sees on, Willoughly's camera store in New York City lass inaugurated a special department in its store manual by no color expert ready also and equipment. The management express and expuspment. The management express that thus department will fill a real need and become out of the sure's most active services.

FLOWERS IN THE PARKS

NE of the chief reasons for the failures experienced by amateurs in shooting pictures of blossoms and flowers is due to the fact that too much of the subject is included in the view. Of course, we know it is very difficult to isolate a subject in such a manner that it is made to stand away from

the rest of the branch and still be appropriately lighted and have the sky for background. There is always some way out of the difficulty, even if it becomes necessary for someone to hold a branch in a certain position for the duration of the exposure or to hold obstructing branches out of the way



"Japanese Magnolias"

of a particular subject. Lighting as very importunt, for a promising subject will be missed completely if the lighting is unstituable. One of the most effective methods is that of back lighting, illustrated in the accompanying picture of magnolas. Notice, too, that an effort was made to bring about a good balance in the composition by including the bud in the lower left-hand corner.

X-33 FINE-GRAIN

FORMULA

UNTIL recently a closely guarded laboratory secret, the formula from which the developer X-33 is made up has now been disclosed by the makers. The formula follows:

The chemicals are mixed in the order given, each thoroughly dissolved before adding the next. The solution may be used inmediately after cooling.

FOCUSING KINK

WHEN working at fairly close range on and which must appear, sharp from front to back, difficulty will be encountered unless a certain well tried rule of focusing under such circumstances a employed. Suppose

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RAYGRAM CORP

the front of the subject is 20 inches from the lens and the back of the subject 30 inches from the lens, namely, a depth of 10 inches in all. In order to determine the point at which the camera lens must be focused, it is necessary first to multiply the two distances, namely, 20 by 30 and the result by 2, which comes to 1200, Next, add the two numbers, 20 plus 30 equals 50, and divide this into the first result, 1200. The answer is 24. Therefore, it is necessary to focus on a point 24 inches from the lens disphragm or 6 inches from the back of the object. Focusing on this point is done with

the lens wide open and the closing down of

the lens brings both front and back of ob-

ject into sbarp focus TIME EXPOSURES AT

THE ZOO

MANY persons are discouraged from pic-ture-making in 200 interiors because of the poor lighting available. However, if one watches his chances he will frequently be rewarded with opportunities such as that encountered by this department in the alligstor subject here illustrated. The alligators were as still as though carved in stone and a full, unobstructed view was afforded by the large window behind which they were en-



"Alligator Siesta"

joying their afternoon siesta. Because there was such a large shedow area, a relatively long exposure was required, especially in view of the stop f/8 that was required to bring the several subjects into sharp focus. An exposure of 20 seconds was made possible without the use of a tripod by resting the miniature reflex on a ledge and slightly tilting the camera by tucking the front of the eveready case under the camera.

KALART CONTEST

TWENTY-FIVE awards of \$10 each are offered in a photographic contest sponsored by the Kalart Company, who will pay the total of \$250 for the best pictures taken with a Kalart Micromatic Speed Flash. Closing date is December 1, 1939, and there are no restrictions as to type of flash pictures time when taken, and so on. Print sizes should range from 2% by 3% inches to not larger than 11 by 14 inches. Enlargements and contact prints are both acceptable, Nega**_and** you're photographing in color



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The contest will be judged in three divisions, as follows: Division i Human- including portralls and other content sindles

Division 2 Landscapes—tochiding aft scene views a lose-ups of parts of landscapes, seasones, and so

Division 3 Action—including all types of photography in which ac-tion is the predominating feature

In each district there will be prizes of two Loopines watches— The World's Most Honored Watch, and two ted eral Foloriers a well as five Honor able Monton Awards

"Watch wiegers may make their own selection of

PHOTOGRAPHY CONTEST

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Specific rules for this contest were published in our May number, Be sure to read them before you submit prints.

This Conicsi Closes December 1 1939 of Which Time All Entries Must be in the Hands of

Photograph Contest Editor, Scientific American

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try's should not be sent until requested. The fullowing data should appear on the back of each print submitted. Make of camera, las, shutter used, shutter speed, lens open ing, filter used, if any, film used, size and number of flash bulbs used and distance from subject, if taken in daylight, include position of sun and time of day. Entry blanks may be secured from dealers

SHADOW ON PATTERN

N intriguing pattern such as that of the floor in the illustration would normally be lacking in picture interest, but add to if the lively shadow of the walking boy silhonetted against the bright sky and you have



"Patterns"

a subject worth shooting. The stop fold was used in order to get satisfactory sharpness from foreground to boy subject; the time being late afternoon, 1 25 of a second was the fastest shutter speed we could attempt This was not sufficient completely to stop the movement of the boy's raised leg, but this does not appear to have seriously ham pered the general effect.

OVAL TABLE ELECTIONS

TWO recent additions to the Oval Table Society, Inc., of New York City, sponsor of several of the most important photographic shows in recent years, have been the electhe country's leading color photographer, and C W. Gibbs, A.R P S, a man of the laboratorics who has become widely known as a writer on photographic subjects. The Society's ruster of some of the best known photographic workers in this country is thus increased by two names with enviable repu-

ARGUS RADIO PROGRAM

A SERIES of transcribed radio programs featuring Karl A. Barleben, F.R.P.S., is being sponsored by the Isternational Re-search Corporation under me title, "Today's search Corporation under the line, about a Candid Story" The series is being used by photographic dealers' in several cities throughout the country over their local radio stations. The series is one of the first camera programs to be sponsored by a photographic manufacturer and presents the fast-action, true-life type of camera drama.

"STROLLING SHADOWS"

OPPOSING shadows in a diagonal frame constitute the chief attraction of this picture shot from the seventh floor of our apartment house, and the little dog helps to fill in an otherwise barren space. The height being so great, we were obliged, by the focal



"Strolling Shadows"

length of our lens, to choose patterns that would compose satisfactorily in a large space. To this end, we watched the "strolling shadows" as they passed in and out of the area until the idea of opposing figures brought the answer to the problem and provided a picture in which the figures, though small, adequately filled in the space by the length of their shadows.

SPOTS ON SEPIA PRINTS

To remove the stains and spots which occasionally appear on sepia prints, practical workers have found hydrogen peroxide to be fully effective. This is simply poured over the spots or stains or applied with a wad of cotton. A rinsing completes the job

CAMERAS AS POLICE EQUIPMENT

THE Beverly Hills (California) Police Department is now equipped to go after law violators both with gin and camera Re-cently Police Chief Charles C. Blair, of that department, bought a number of Univex Mercury cameras for use by all officers of his department. Which prompts F. G. Klock, of the Universal Camera Corporation, to remark that he wonders "if the day isn't rapidly approaching when every city policeman and town constable will tramp his beat with a candid camera sling over his shoulder.

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ENLARGEMENTS XXX



JACOB DESCHIN, conductor of our "Camera Angles' department, will nsuer in these columns questions of general interest to amateur photographers IJ an answer is desired by mail, enclose a stamped, addressed envelope. Queries should be specific, but Mr. Deschin cannot undertake to draw comparisons between manufactured products nor to advise on the purchase of equipment or materials - The Editor

Q. I am in the market for a 35mm. ra and would like your unbiased opinion on the following: I have nurrowed the field down to include three earnerus, two with Compur shutters to 1/500 of a second and the third with focal plane shutter speeds to 1/1250. The first two are equipped, respectively, with an f/2 and an f/2.9 lens, and the last with f/2.8 lens. All have coupled range finders. I would like to take pietures under adverse conditions, including indoor and night shots, I would appreciate your comparison of the three cameras, including the following: Shots possible with 1/2.9 lens and its limitaons, quality of lenses, advantages or disadvantages of the two kinds of shutters, whether 1/1250 of a second ca be used with an //2.8 opening. I would also appreciate the names of better quality cameras in the same price class and also the names of enlargers,-S. J. S.

SCIENTIFIC AMERICAN

A. It would need a Solomon greater than he of the Bible to tell a man what camera he should buy, so many are the variables and so much depending on the individual's requirements and his personal taste. It seems to us that probably the best adviser on this score is the local photographic dealer, Usually he has no axe to grind, he sells all kinds of cameras and he would just as soon sell you the one as the other Let him give you the benefit of his experience, based on his contact with the many persons to whom he has sold cameras in the past The three cameras you mention all have their good points and all will make good pictures once you learn how to use them.

Pictures under adverse lighting conditions may be taken with any lens provided you allow enough exposure Even moderate snapshots can be made in poor light if this light is sufficiently close to the subject and your film is of the "super" type. Under certain "adverse" lighting conditions, even a lens
of f/1.5 speed will be inadequate.

On the question of lens choice, see our reply to J.G.B., June issue; the 1/2 you refer to may possibly have a little "edge" on the others. If very high shutter speeds are what you want, you will find the focal plane shutter preferable on this account.

Many prefer the Comput because it has a tradition of reliability Nevertheless, some of the highest priced and most efficient instruments on the market today have focal plane shutters and are none the worse for bring so equipped. The use of very high shutter speeds is entirely a matter of the amount of light available for photography and the sensitivity of the film emulsion in your camera. Therefore, a 1/1250 exposure at f, 28 or even smaller stop is entirely pos sible; generally, the necessary light volume will be available only when shooting outdoors on a bright day.

As to your last request, you may find the an-wer by making a tour of the photographic shops or by writing to the manufacturers and dealers whose advertisements appear in these columns

Q. 1 .-- I have read statements of certain professionals who mentioned that they had bought a Contax and had it thoroughly checked by Carl Zelss before they went to work with it. Does this mean that some lenses of the Sonnar //2, 5cm specifications, for instance, are capable of hetter results because of the greater accuracy in manufacture? If so, will Carl Zeiss cheek any purchaser's camera, so that he may feel confident that, from the equipment standpoint, Toni Frissell has no better chance of getting a sharper negative than him-self? 2.—Is there any possible way of obtaining a sharper projected image for enlarging than using my Sonnar //2, 5cm lens in the Magniphot enlarger? Is there meant to be any adjustment on the light source in this enlarger, or is it fixed? Have you ever seen a direct enlargement made from any 35mm neg tive to the tremendous size of Toni Frissell's exhibit prints? Even considerrissell's exhibit prints: even constitution in intermediate negatives, how is it possible to preserve such hair-line detail? And where did the grain go? 4.—

Who makes the enlargements for the Zeiss and Leica exhibits?—H. W. E.

A. 1.—Carl Zeiss or any other company will gladly check the accuracy of a camera lens for the mere asking. The reason a pur-chaser desires a check-up is due to the natural feeling that a camera handled on a store

counter, perhaps dozens of times before the actual purchaser came along, may have been slightly mishandled by inexperienced hands. A professional photographer must be sure of results from the stert, particularly if he s about to undertake an important assign ment. Even if he wishes merely to try it out for a while before actually getting to work with it, he wents to be certain that he is starting off on the right foot and that if there is something wrong with the results, it is probably due to his unfamiliarity with the workings of his camera. Provided you operate the camere properly, your negatives will be just as sharp as those made by Toni Frissell or any other experienced professional worker The lens that you get with our camera is not a whit better or worse than a similar one furnished to Toni Frissell.

2 -The sharpness of the projected image is governed by the precision with which you focus the image on the easel and your Sonnar will give you this sharp image if you focus carefully and accurately. The light source is admistable as to distance from the negative holder

3 -We have seen prints of this size and even much greater made from a single 35mm negative. The preservation of detail and the lack of visible grain ere due entirely to good processing throughout from the development of the negative to the final print-We have it on the word of the Zeiss in# people that the Frissell enlargements were made directly from the 35mm negative and that intermediate negatives were not used. In fact, they add, direct enlargement is one of the chief contributing factors to that preservation of detail and tone gradetion which you admired.

4-The enlargements for both the Leuz and the Zeiss exhibitions are made by the individual photographers themselves possible exception is in the case of displicate prints for traveling exhibitions or when the company has acquired a negative as the result of a competition or otherwise. The large mursls are naturally made by an outside finisher because the average photographic worker does not have the facilities for turning out prints of this size.

Q. I have a Rolleleord f/3.5 and would appreciate advice as to what lens opening and distance to set for fixed focus exposures.—W. L. P.

A. If you will set the distance at 10 meters and close down the lens displiregm to f/11, everything will be in focus from five meters -that is a little over 16 feet-to infinity. The stop f/16 will give you a still deeper field of focus, namely, a little under 12 feet as the closest distance when the meter scale is set at about seven meters.

Q. I recently constructed a small print dryer similar to commercial dryers, topped with a curved chromium plate and covered with a removable piece of canvas. Heat is supplied by two 100-watt electric lights in the interior. The dryer works well when ferrotyping glossy prints, but causes matte prints to wrinkle all around the edges. Is there any way that this wrinkling can be remedied? The first batch of prints, by the way, usually does not wrinkle, but the following batches do.-W. H. B.

A. Application of too much heat is prob-

edges of the matte prints. Since the first batch of prints does not wrinkle, it is suggested that you attempt to determine the approximate temperature at which the first batch was dried and try to maintain this heat, as nearly es possible, for the succeeding batches,

Q. Is there any difference in performance, other factors being equal, between dilters of the stained opticalglass type and the gelatin-cemented-inglass type? Cemented gelatin light filters are frequently described as being available in A glass or in B glass. Just what is the difference between A glass and B glass? What, in a practical sense, ie the importance of this difference in general photography?-J. A. R.

A. So far as performance as concerned, there is practically no difference between the stained optical-glass type and gelatinbetween-glass types of filters. The principal difference lies in the fect that masmuch as in the one case we have a solid, colored disk of glass, and in the other we have a piece of soft gelatin between two protecting cover glasses, the latter is obviously sus ceptible to certain hazards from which the other is free. Among these hazards one must include the facts that the latter may not be exposed to the sun for too long a period, must not suffer too great pressure, and must generally be given greater care than the solid glass type. The A glass consists of so-called "optical flats," of the highest quality but too costly for general photographic use. The B glass filters are the most generally used and are satisfactory for regular photographic nurnoses.

Q. Will you please give me what in-formation you have on the subject of enlarger adapters for conventional cameras? I am informed that such an adapter, when properly adjusted upon th ordinary camera, with back removed, yields quite satisfactory enlargements. The camera lens, of course, serves to expand the image and, for this reas the cost of the device is relatively low in comparison to the prevailing prices of regular enlargers.—G. W., Jr.

A. There are available such enlarging attachments, permitting the owner of a camera equipped with a removable back, to convert his camera into an enlarging outfit by altaching the enlarger liousing unit and negative holder. The projection of the image is usually horizontal instead of the popular vertical arrangement employed with regular enlargers. The cost of such a unit is con siderably lower than that of a regular enlarging outfit, but it is significant that these nnus are not especially popular, workers generally preferring the complete outfit rather than an adapter.

Q. I would like to learn how to develop my own pictures. Could you give me a list of what I would need and directions?-J. N.

A. A number of developing kits are available containing the necessary equipment and supplies for developing negatives and making prints from them. These kits also include a short explanation of the photographic process and directions for developing and printing. In addition, it is suggested that you obtain a copy of an inexpensive elementary handbook, which your dealer can supply for 25 or 50 cents.

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TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker Conducted by ALBERT G. INGALLS

PEW refracting telescopes are made by amateurs—perhaps because of the time and accessories needed, but largely, it is suspected, because in earlier years when amateurs regarded optical work with awe and mystery a tradition that objective lensmaking was very advanced work became established and has not yet been seetched Yet, whenever somecuse who has made one



Figure 1: Garrison and refractor

writes to this magazine, he never mentions any especial history of trials, 'Industrons, and headaches. The job, with its four surfaces to work, is a bit tedious, and probably should not form the beginner's madern optical work, but for all its tedium it is not more difficult than reflector making not more difficult than reflector making the working tolerance, in fact, is not so close. It is suspected also that in earlier years many who dured not tackle a refractor convinced themselves, because of this fear, that the reflector was upperfor But most persons who are honest with themselves and who know both instruments do

not say this. Each type has its superiorities, one superiority for the refractor being much steadier images.

In Figure 1 is an 8" refractor made by H. P. Garrison, R.F.D. 1, Oceanside, Calif, working from the very detailed instructions by Haviland in "ATMA", the companion volume to "Amateur Telescope Making"

"The objective lens," Garrisou writes, "was made from a part of Chance Brushers liard crown and deuse flint, ground to a focal length of 134%," or /1/10 51 1 pent much time regranding and polshing five times, but 1 did not mund that because twa-learning all the time Now I have a lens that will stand 75 dameters' magnification to the aputitor inch when the seeing is good, and I feel! an were well repaid for the extra

"The mounting is made from Chevrolet truck peris, steel pipe, and boiler plate, and the axes are mounted on ball bearings. The tube is of 20-gage galvanized iron 8½" in diameter.

"The mounting works very smoothly bill, in the wind, as shown in the illustration, taken before a 14' by 14' roofless observatory with 6' walls was creeted, it was very

"The cell, Figure 2, is made of aluminum cast in one piece, and is held in place by means of brass clips. This permits removal of the leas without disturbing the adjustment."

PRAMED attractively in the twigs of a Pneghboring tree, as shown in Figure 3, stands the huge, 137 dome for the 200° telescope, atop Mt Palomar, California, with the great mounting inside practically ready to receive the big mirror next year This artistic photograph was taken by Ted Watterson, official photographer at Mt Palomar

Figure 4 is a 1/340-scale replica of the same great dome, cast in brass and aluminum by Fred Ferson, 404 Reynoir 5t, Bilox, Miss, author of the chapter on molding and casting in "ATMA". The patter and presented to Ferson, a friend. Ferson them, and provide the authority, method them, and makes of this replica is most attractive desk, and of this replica is most attractive desk, and of the replica is most attractive desk, or other, comment—suitable last for adaptation as a cigaret humdor, ash receiver, or other ultiny Ferson hopes to malal in some of these replicas a model of the 200° telescope table, if there is enough demand.

The base is 8½" in diameter, is made of brass, weight about six pounds and is let 'tered' Two-hundred Incli Telescope Observatory A D. 1940. "This brass base includes an integral standing collar part reaching upward as far as the bead seen above the entrance dourway. The upper portion is east

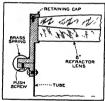


Figure 2. The clip-attached cell

in alimmum, contrasting attractively in hie with the brass base, and consists of a hollow spherical dome 5%" in diameter, to which an accurate replica of the shutters is attached facely. This upper portion may be rotated, as on the original, also lifted off to get at the interior, which is machine-finished.



Figure 3. Big dome at Mt. Palomar



Figure 4: Ferson's big-dome replica

Sharp-eyed comparisons will reveal that the entrance door in Figure 2 differs from that in Figure 1, the original. These, however, are different doors and on different sides, the door in the replica being the huge one for the introduction of the big mirror and the other merely for the introduction of the autonoments.

In Figure 5 are two lesser items cast by casting-enthusiast Ferson. The larger is a



Figure 5: "Mirror Maker" and "Nut"

Ad once brass plague, 5° by 76", made from a pattern by Porter who, when vusting at Ferson's home, poured plaser that in the pattern of the plast in the pattern of the plast in the pattern of the "Mirror Maler" westing and arraining at his work of preluminary polishing. The smaller piece (32 ounces) is a brass "Telescope Nui" pering into an abrass "Telescope Nui" pering into an average when the present of the pattern whitted out by Porter. The two photographs on page 337 of "ATMA" show Ferward for the pattern whitted out by Porter. The american support of the pattern whitted out by Porter the american support of the pattern whitted out by Porter. The american support of the pattern whitted out by Porter. The american support of the pattern whitted out by Porter. The american support of the pattern white pattern white do the pattern white patter

STELLAFANE'S annual convention or informal get-together of amateur telescope makers and astronomers will be held stop Mt. Porter, near Springfield, southeastern Vermont, on Saturday, July 22. All having interest in astronomy or telescopes may come freely and bring families, friends. They will find about 200 others similarly afflicted (that is, telescopitis, families) sitting on grass or hard outcrops of Vermont Jurassic schists ready to swap chin-music about telescoptics from noon to six. Then comes supper en masse in a hig circus tent (about a dollar). At dusk, reports and peeches by amateurs from hither and von begin and wear on till all are unconscious. following which those who revive may stay all might, using Stellafane's telescopes and those brought by visitors—bring yours. Good parking Places to camp. Bubbling spring, Scenery, Air. Not a mosquito,

IN February 1938, in these pages Clyde Tombsugh of Lowell Observatory, de-cribed his un telescope: a 12" mirror, undered, a right-angled prism with diagonal way of the control of the con

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THE BEGINNER'S CORNER

PORTABILITY around a yard hat no farther is often desired in a telescope and the two shown here were designed for that purpose; they are mounted permanent by on wheels. The one at the left is a 6" reflecting instrument built by Robert M. Peterson, 455 Seminole St., Oradell, N J., apparently with cart or perambulator wheels as its base. The mounting is the regular double yoke type, which is very easy to build and very solid. The tube shown is octagonal, made of wood, an excellent substance for a telescope tube-better, many think, than metal because a slow transmitter of the heat effects which deteriorate optical

Intages The 9" reflector at the right is far heavier -700 nounds. Here the only desug was to



Peterson and his portable mounting



Friend's semi-portable mounting

wheel the telescope no farther than out of a garage and a few feet distant on solid paths from H Friend, 40 Cooper St., Torrington, Conn , is the maker of this instru ment. The tube is square and built of angles and welded bands-very rigid Where a mirror is in the open, as this one is, a pair of cloth sleeves may be slipped temporarily over the ends-say, if your neighbor turnon a bright light nearby, for stray light makes trouble. This particular telescope haa Telechron motor drive in right ascension but the beginner may safely forget this refinement However, he may well study the cleanness of this piece of workmanship

TELESCOPTICS

(Continued from preceding page)

8 or 10 degree, plate glass prism Alan (see, "ATMA" p 320, a cadet at the United States Military Academy, West Point, N Y, in rummaging round the pre viously unused but recently rehabilitated observatory there, ran across the item shown in Figure 6, an old polarizing diagonal of considerable value, and at our invitation he describes it as follows.

"A diagonal employing the principle of polarization by reflection to cut the Suns light and heat down to a minimum without cutting the aperture (see Bell, "The Telescope", pp. 167-8) gives beautiful colorless views of the Sun The following is a descrip



Figure 6: The polarizing diagonal

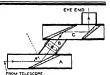


Figure 7: A longitudinal section

tion of such a diagonal (probably made by Alvan (lark about 1880) as used on a 12 refractor of 180" focal length at full aper-

"The construction of this diagonal is very imple. It consists essentially of three wedge (Herschel) prising, two of which are so mounted that the incident and reflected rays to each make angles of about 57 degrees with the normal to the reflecting our faces and thus are plane-polarized. The third wedge is intended to increase the available hghi range and to get a favorable observing position, and is mounted just in front of the eyepiece like an ordinary diagonal. Figure 7 shows the arrangement schematically, and Figure 8 as it appears in use. The tubes of the diagonal are of brass, soldered at the necessary angle. The two separate parts of the diagonal—the lower part A, (Figure 7) carrying one prism and attaching to the 'scope, and the upper part C carrying two prisms and the eyepiece—rotate with respect to each other about the short connecting tube B. This rotates the planes of polarization and thus controls the amount of light

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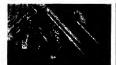


Figure 8: Diagonal on 12" refractor

passed on to the eyepiece and eye
"For minimum light," Gee continues,
"tube C would be perpendicular to tube
A, as shown in Figure 6; for maximum
light they would be parallel, as shown in
Figure 7.

The wedge prisms in this particular diagonal are mounted against soldered shoulders in separate pieces of tubing that slide into the soldered tubes forming the angle. This simplifies construction and allows removal for cleaning.

"The angle the wedges must make with the incident ray is a function of the index of infraction of the glass used. The equation, tangent $\theta = \mu$, where $\theta =$ the angle between incident ray and normal, and $\mu =$



Figure 9: The diagonal disserted

index of refraction, gives the exact value of the angle. For ordinary glass (μ =1.55, approx) the angle is 57°. As all the incident rays are not parallel, anyway, this close enough for most conditions. However, if a particularly light or dense glass used, the cauct angle should be calculated.

"Silvered surfaces or the like will not polarize by refection, although colored glass will Black glass can be used in place of widep grams it available, but abould be used with the litrid wedge of clear glass to discared text heat. The new polarizing materials now on the market, issually consisting of this abect that polarize by transmission, are not suitable for a diagonal. They pass the volet and deep red (and most of the heat) even when set for extinction, and thus are but little superior to any colored filter. Nicol prisms will work if available but are far toe expensive size which is a suitable prism and the superior to any colored filter. Nicol prisms will work if available but are far toe expensive.

"The biggest advantage of this type of diagonal lies in the fact that it cuts down the light (and heat) without cutting the aperture and without coloring the image. No colored glasses are needed. The Sun appears perfectly white and can be rigidly controlled in brilliance simply by rotating one tube with respect to the other. The difficulties of construction should not be great, the optical surfaces representing most of the work. If used on a reflector one of the wedges mounted at the required angle could well replace the main diagonal, the other being mounted before the eyepiece. The beautiful views that such a set-up gives of the 'rice graine', spots, and faculae on the Sun surely make it worth considering."

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THE maxim "It at first you don't succeed, by you have been a try, try again does not supply to patent longation." It is man sout first by a patenter against the manufacturer of an article, it is decided that the patent is mysdid or not infringed by the article in question, the patenter cannot rehitigate the same question as suit against a customer of the manufacturer charging that the same article infringes the patent.

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"In such case we think that the patentice is estopped by the judgment in favor of the manifacturer from recovering damages on account of infringement from persons who have purchased from the manifacturer the articles which are alleged to infringe but which in the judgment have been held not to infringe."

FOREIGN INVENTION

WHERE a patent is obtained in the United States by a non-resident who developed the invention abroad, the question frequently arises as to the date of invention to which the non-resident inventor is entitled. In other words, under our patent law, is the non-resident inventor entitled to the date on which be conceived, developed and reduced the invention to practice abroad, or is he limited to the date on which he first introduced the invention into the United States? Arbitrary and illogical as it may seem, it nevertheless is a fact that, if the question arises in a proceeding between the non-resident inventor and an infringer owning a patent or a patent application covering the same invention, the non-resident is only entitled to prove the date on which he first introduced the invention into the United States, whereas, on the other hand, if the question should arise in a suit brought by the non-resident against a person who

does not own a United States patent or patent application, the non-resident is entitled to prove his date of conception and reduction to practice abroad.

This is illustrated by a decision of the United States Supreme Court in a suit for patent infringement brought by a resident and citizen of Japan against an American company. One of the patents in suit was applied for in the United States in January, 1922. It was proved by the American com pany that it had used the invention covered by the patent in commercial operations since June, 1921, almost a year prior to the filing of the patent application. However, the American company did not obtain a patent on the invention. It was held that under those circumstances the Japanese was permitted to prove that he had conceived and reduced the invention to practice in Japan in 1919 which was prior to the commercial

use by the American company The Court pointed out that if the Amer ican company had obtained a patent in the United States the Japanese would have been precluded, under the American patent law, from proving his dates of conception and reduction to practice in Japan and would have been limited to the filing date in the United States as his date of invention. Under those circumstances, the patent would have been invalid because of knowledge and use in the United States prior to the proved date of invention by the Japanese. This rather arbitrary distinction as to the rights of a non-resident inventor against an American patentce on the one hand and against an American who does not own a patent on the other hand places a penalty on an American who does not obtain a patent on an invention. The Supreme Court recognized the arbitrary character of this distinction but said that it could only be corrected by legislative action since the courts were bound by the patent law as enacted by Congress

In this connection the Court stated:
"We have no way of knowing whether the
discrimination results from inadvertence or
from some undisclosed legislative policy,
but, in order to redress the disadvantage
under which one in the petitioner's situation suffers, we should have to read into the
law words which plainly are missing. We
cannot thus rewrite the statute."

VINYL RESIN

WHEN does the substitution of one material for another constitute invention? Ordinarily the substitution of one material having known characteristics for another material having similar characterlatica does not amount to invention with though improved results might be obtained. However, where the substitution one material for another produces a new and unexpected result or where it solves a problem of long standing in the art it sheld that the substitution constitutes inven-

The principles of law set forth above are relatively simple but the application of the principles to any particular set of facts is quite difficult. The difficulty presented in such cases is illustrated by a recent suit brought against the Commissioner of Patents to compel him to issue a patent for an improved package or container. The package consisted of a metal container havng a coating or lining formed of vinyl resin for the purpose of protecting food products packed therein Other coatings or lining materials had been used on metal containers and it was argued by the Commissioner of Patents that the substitution of the vinyl resin costing for other types of coatings constituted a mere substitution of materials and did not amount to invention.

The Court found, however, that for many years it had been recognized that it was desirable to coat metal containers for food products with some type of material that would protect the food product from the action of the metal However, no satisfactory coating material had been developed for metal foil used in packing cheese or for metal containers for beverages. The Court found further that the use of a vinyl resin coating material for these purposes solved the problems of the prior art and provided a satisfactory package that could be used with all types of food products. The fact that the substitution of one material for another resulted in solving a problem of long standing in the art was considered by the Court to be proof of the fact that the vention and warranted the granting of a patent.

PERSONAL PERFORMANCE

A MUSICIAN or other interpretive artist may control the use to which electrical transcriptions of his renditions may be applied. This is illustrated by a suit brought by an orchestra leader against the proprietor of a radio station to restrain the unauthorized broadcasting of electrical transcriptions of renditions by the leader's orchestra.

The orchestra had made certain electrical recordings to be used on a specific radio program and the records contained a notice that they were to be used for that purpose only. The proprietor of the radio sistion used the recordings in connection with an inauthorized program and the leader of the orchestra filed suit to restrain such unauthorized uses.

The Court granted an injunction, holding that the renditions and interpretations of musicians were property and that the musicians had the right to restrict the use thereof. In its opinion, the Court stated:

mereion in to opinion, the claim states of the day give something to the composition that is a particularly hierarchically theirs, and to say that they aparticularly hierarchically theirs, and to say that they aparticularly hierarchically their and the properties of the composition of the composit

MANY STILL ARE NOT AWARE

that there is a companion volume to "Amateur Telescope Making."

"Amateur Telescope Making -Advanced"

N OT merely a new edi-tion of the book "Amateur Telescope Making," but a wholly different work for owners of that beginners' book who have absorbed its contents "Amateur Telescope Making - Advanced" has 57 chapters, 650 pages, 359 illustrations and over 300,-000 words, dealing with advanced mirroi technic, flat making, eyepiece work, drives, aluminizing, observatories and many other aspects of the optical hobby Published 1937.

"Amateur Telescope Making -Advanced"

Edited by Albert G. Ingalls

Postpaid \$3.00, domestic \$3.35, foreign

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LACOB DESCRIN, Amsteur Protography

CHURCHILL ERSENRART Postarization of Matther.

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NINETY-FIFTH YEAR

ORSON D. MUNN, Editor

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More Oil from Crooked Wells-By Upton Close

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BY means of the method described on page 84 of this assue, for drilling oil wells at controlled angles from the vertical, it has been found possible not only to obtain more oil from underground sources but also to extinguish raging oil well fires and to bring "wild" oil wellunder control. The secret of the process hes in the ability to direct and change the angle at which drilling proceeds.

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50 Years Ago in . . .



(Condensed From Issues of August, 1889)

ELECTRICUTION—"A nurderer in New York named Kemniler has been sentenced to draft, and his execution will be the first inder the newly enacted law by which electricity is substituted for the rope hanging heing abolished."

EXPOSITION.—"Nations to the Paria Exposition take great placasare in hearg carried from one end of the Machinery Place to the other on the electric rolling bridges, a general view of whether on given in our engraving. In fat, they are not indifferent, whether on foot or on this original vehicle, to traversing the 1300 feet of the collowal gallery in which are accumulated so many wonder-



of mechanics Morrover, many of the visitors, if not all of them, experience an intelligent sistantion in thinking that the microver power necessary for this aerial trip is furnashed by electricity and constitutes an interesting cample of the transmission of electrical netry to a distance—that problem which is now in a large measure wheat.

ICE WATER—"In the opinion of the editor of the Sonatory Lolanteer, there is a great edd of sentiment and many opinions regarding the use of ier water that vanish when the light of reason and experience is turned upon them. The fact is that iev water, druik showly and in moderate quantities, constitutes a healthful and invigorating drink. The assumption that need water is diagrenus, and that need tea, or need coffee, or feed lemonade is a harmless subscittin, 15 simply a delmino."

DIAMONDS—"The practical production of the diamond by artifical means has been the theme of a great deal of thought and a good many experiments, but up to this time it has elided all the efforts of the experimenter, though earline crystals closely approaching the gern have more than once been secured, while many persons still think it is merely a matter of time, and not a long one at that, when the secure will have been wenched from nature."

PATENTS—"The Supreme Court has repeatedly said that a man's right under his patent for an invention is as absolute as under a patent for lands, and no one would say that one should lose the right to his house because some one clee saw fit to take possession of it against his will."

FLIGHT—"When human ingenuity can match the preduct of nature, when it can make a machine possessing as much power and indiractive to the other of weight as that of the homing pigeon which lately five from Detroit to Buffalo (225 miles) in less than four hours, when it can so arrange and automatically shift a series of vances like shifting feathers in a hawks wings, which suspend it in the air for hours almost without apparent motion, when it can it in the air for hours almost without apparent motion, when it can solve the problem of how this same hawk drops like a bullet from the dezving height of a half mile, and checks itself inharmed above its pres, then it may learn to travel in the air."

REJUVENATION "Dr. Brown-Sequard's paper, lately communicated to the Societe de Biologie, of Paris details the remarkable fifets produced in his own person and also in several other men of advanced years, by the subcutaneous supertion of substances derived from the testical protings of the bodies of certain animals."

BORAX—"New horax works have recently been started in Salinevalley, Inyo county. California They have cighteen crystallizing tanks, each of a capacity of 1000 gallons. Three of these tanks are emptted daily, yielding about two tons of borax."

TRANSSIBERIA—"The proposed Siberian railway is to extend from St. Petersburg to Vladivostock on the Pacific Ocean, which is located nearly opposits. San Francisco, and distant therefrom about 1000 miles. Branch lines of the proposed road would extend to Pekin The new road would be about 4300 miles in length.

ELECTRICITY—"There are now in use in the United States more, than 5.50 central electric stations for light and power. There are 21,0000 are lights and 2,600,000 incondescent lamps. There were fifty-more electrical ratioways in operation in March last, of eighth via roads in process of construction. The increase of capital in electrical innestments domain 1888 was nearly \$70,000,000."

WARSIIIPS—"On August 22, proposals are to be opened at the Nay Department for five new crusters, to be built on plans copied from what are now obsolete English ships, down no peed, lacking in offensive and defensive means, not the latest and heat designs. It is to be hoped the execution of the Nay will be able to defer the award of construction until Congress meets and time is given to modify the proposals so as to substitute later and better designs."

CIGARETTES—"Observation in public places gives satisfactory evidence that the use of cigarettes is rapidly on the decline. Whether this is due to the stringent laws passed in many of the states against selling them to minors, or that smokers have come to their senses and have taken warning from their own expenses and the unanimous condemnation of smoking caparettes by the medical profession, or whether the evil practice has begun to be looked upon as a discreditable vice to be only practiced in secret, we know not, but it is certain that, as compared with the past, very few cigarettes are now smoked in public."

PHOTOGRAPHY—"Modern amateur photography . . . consists, vubstantially. in punting a camera and touching a spring it requires no study, no knowledge, no experience, no genus, no skill. Even children are now photographers, and the camera is coming to be a toy."

AND NOW FOR THE FUTURE

Cancer Research Looks Forward, by Barclay Moon

CHydraulic Engineers Use Small-Scale Models'in River Control Studies, by Paul W. Thompson,

CMystery of the Earth's Magnetism, and Steps in the Solution, by Charles W. Sheppard.

CModern Dog's Ancestry Traced 5000 Years by Archeologists, by W. H. Noble, Jr.



BELL TELEPHONE SYSTEM



 The Bell System cordially invites you to visit its exhibits at the New York World's Fair and the Golden Gate International Exposition, San Francisco.

OUR POINT OF VIEW

Upward

WHILE a fear-ridden world is talking for onthing but war, it is truly refreshing to hear another note sounded—one that includes the word "armaunent" but with a meaning far removed from warfare. From England, the Seandmain countries, the King of Belgium, the Queen of Holland, and now from the President of our own country has come a call—a call to arms. But what a different call, for this is a call for more of removed the countries of the countri

These far-seeing people realize, as everyone must, that unless something is done, disaster will overtake the nations of the world as it has in the past We must not forget that nations are aggregates of individual beings, and until man changes himself we cannot expect nations to be very different. Aesop long ago, in the fable of the human body, pointed out a great lesson-that every one of us is dependent upon each other. When the individual himself will put into practice the fundamental principles of unselfishness and honesty, we will find in our business life and in our national life a great change; and as the individual and the nation change the international peace of the world will be assured. We will have both national and international peace and prosperity .- A. M. T.

Commerce

SOME months have passed since the liner Perus burned at her pier. Yet that disaster still may serve as an object lesson to shipbuilders throughout the world. Fire may strike any ship, large or small, if built by traditional designs and of the usual materials. And when it atrikes, sometimes there is a glassify tell of life, as was the case when the Morro Castle burned off the New Jersey coast several years ago.

As we contemplate with no little national pride the plans for upbuilding the American merchant marine (discussed) by H. Gerrish Smith on other pages of this issue) a greater pride grips us at thought of all that American designers and experts have done to make all our new ships fireproof. Fires can start on practically any of them, but will burn themselves out quickly. The principle behind the use of the newer designs and the newer materials is to insulate each partition, each bulkhead, each deck, against any spread of a blaze.

The details of the fireproof features of the Ancon and the Panama, of the Panama Railroad line, were discussed briefly in the April, 1939, issue of Scientific

Albert A. Hopkins

EDITOR, author, autiquarian, bibliophile, Dickens scholar—wide were the interests; industrious the mind, kindly, considerate, and tolerant the action of his man whom we called friend and our readers looked up to an merito. Our Assoriate Editor for 44 years until his best of the consideration of the consideration of the property of the consideration of the consider

Mr. Hopkins followed in the footsteps of his father who was also associated with Scientific American for many years. Edsting and writing came so easy to him that he found time for many other broad interests during his busy and productive life. Fame. which might have been his for the asking, held no glamor for hun, for his was that rare mentality which loves achievement for its own sake. He wrote, compiled, and edited a large number of books, at least one of which sold into the hundreds of thousands. An authority on the history of art, he collaborated with the late Edwin Howland Blashfield in editing Varsari's "Lives of the Painters." To the New York Public Library, he presented a valuable collection of 4000 mounted photographs of Italian paintings and statuary. He was one of the guiding forces in the Dickens Fellowship of New York, a former vice-president of that organization and editor of its publication, The Dickensian. He was also Director of the American Museum of Safety and editor of its official monthly publa atron.

Proponent of progress in science and the arts, and an energetic, indefatigable worker for those ideals that make men great. Mr. Hopkins achieved a unique greatness of his own, a transcendent joy in the art of living. He took the utmost from life and gave full measure in re-

We shall miss him for we were honored to call him friend.

American. The America, largest merchant vessel ever constructed in this country, will be made, in a similar manner, proof against fires. Likewise, the new construction will be featured in more than 20 combination cargo and passenger ships which are now on the stocks. These are following the lead of oil tankers built during recent years, all of which are immune to sweeping, disastrous fires

Here then, we repeat, are two sources of pride-justifiable pride-for the American people. After long years of apathy toward our merchant marine, years in which we permitted other nations to outstrip us on the seas, we have at last ceased our fumbling attempts to plan shipbuilding programs and will have a merchant fleet befitting our world position No longer may the analogy of the department store owner who delivers his orders in his competitors' delivery trucks be applied fully to us, our own bottoms will handle a much greater proportion of our export and import business than they have for many years. The second-and in some respects more important -- point is that our new ships will be the safest in the world. We have long stood with the best in general safety but have now definitely taken the lead in the development of completely fireproof ships It is to be hoped that our studies and experience may be made available to and be used by other nations so that fire at sea may some day be a thing of the past -F/D/M

Is Man Sapient?

REENTLY.A C Chek of the Manufacturers Mutual Fire Insuitance Co., tod the Sensological Society of America, Eastern Section, that the volume of Latern Section, that the volume of upward after the Santa Barbara qualke of 1925. The Californs premium alone recacled a total of \$3,000,000, By 1928, however, the premium had fallen to \$2.00,000 and by 1922 it was only \$750,000. Shortly afterward came the Long Beach Qualke ("Oh. My did we let that insurance lapse?"). Exactly the same crescula and diminuendo followed, the total qualke premium for the whole nation today being only \$1,000,000.

Now, since the least dangerous period as soon after a great quake, when earth stresses have been satisfied, and the most risky period some years later when new ones are accumulating, it sounds as though perhaps man wasn't the alto-gether intelligent gambler implied by the term Homo aspiens. An odd sidelight on entonnal effects of recent experiences is that the New England hurricane of 1938 simulated earthquake insurance! This should not be let lapse. The east, too samug about the west's quakes, is largely a seismic area, as it may someday discover to its sortow—d. G. I.

Personalities in Science

DAYTON C MILLER is Professor of playars at the Case School of Applied Science Cleveland, Ohn, Readers will result him as the scientist whose amen figured so frequently in the newspapers a dozen verificial connection with a module experiment on their diff. However, Professor Miller's special in the resets within the field of physics are far broader than either dirft and they include the velocity of light in a magnetic field the exportance of gauss. Roenigen rais, applications of the interferometer, the photographic registration of sound ways, and the quality of museud sounds.

Is there actually an ether! A century and a half ago students of science would have asserted with honest conviction that calone and phlogiston were actual entities having reality Today we know these were merely words with no reality be hand them I argely it is suspected, they required their high prestige from common and frequent use. They were burned into the mind. Half a century ago the wood other had similarly high prestige and solid standing, People took the existence of an other much for granted but it is suspected that the reason again was its common and frequent use, especially in teaching, for there never has been any really water-tight, final experi mental evidence for the existence of an ether. The concept was samply a postn late. Light had to be transmitted by some medium, hence there must be a medium Logic, But logic unsupported by experi ment often leads astray in science Is other then to turn out to be only a word like caloric and phlogiston? There is a marked human tendency to confuse names with things -to name something we think exists and then to feel sure that it exists, or even that we then understand it Thus far, anyway, science does not know whether there is an ether or not, Preponderance of evidence seems against if at present

In 1887, the famous Michelson-Moules, ether drift experiment had given no evidence that there was an ether. Subsequent repetitions his others gave puter totally the same results. Squarely on these findings Professor Einstein based his 1905 through of relativits. Thus, when Professor Miller came to repeat the Michelson-Movley experiment in 1921, 1924-20, and in 1929, it took on greath values about it through the press. After every many & acceedingly laborhous indi-



DAYTON C. MILLER

vidual measurements he came to the behef that he had isolated evidence of an ether drift, therefore of an ether

Scientists the world over awarded Professor Miller's research very close, serious attention, especially because they knew his record and personality and approved of both. The former was that of a careful, level-headed research worker who habitually kept emotional factors out of his mental processes --major part of the method of science itself. The latter was (and still is) genial, calm, quiet, sumple, impretentions, and unaltered by the award of medals and honors. Seentists knew he was not seeking merely to prove" the existence of an ether or out to "get" relativity approaches which would be motivated and therefore contrary to the method of science-but was making an experiment and observing the results. To this day these results have never been satisfactorily explained away Professor Miller does not root vehement ly for them as some might. He says calmly that the details of his work are now in the record, and that the future will prove them true or prove them wrong In this he resembles Professor Einstein who, when told of Professor Miller's findings, calmly said that if they were finally verified the theory of relativity would anto matically disappear. That is seeme

A wide sector in Professor Miller's scientific territory has had to do with sound and music and readers will recall his book, published two years ago en tifled. Sound Ways, Their Shape and Speed," a work for the popular reader.

But he is also a musician as well as a music hore. Skilfil as a flux player, he used that instrument first in his research on small the owner a collection of fluxes of all varieties, numbering no less than 1300. Chaires jade fluxes, walkingstick fluxes, a glass flux one coward by President Madson a human shinone fluxe, after made from the wing of an ergle, an East Indian nasul flux, and many other odd fluxes, also 55 modern fluxes. But he is no mere collector, be can play these fluxes and does

Professor Miller's most recent book is an illustrated, popular, anecdotal instory of electricity named "Sparks, Lightning, Cosmic Rays"



DELICATE BLADES IN A LINER'S POWER PLANT

HIGHLY skilled mechanics are needed for the intreaste job of blading the low-pressure turbunes that will be a part of the driving machinery of the great linet America, now being built as part of the program for a finer increhant marine which is discussed on page 88 of this issue. Some 15,000 of the delicate blades will be required—arranged in circular parallel rows—in the shell, or casing of this turbine. The photograph shows half the casing with semicircular rows of reaction bludes in place. Another 15,000 blades, similar to these but called impulse blades, will be fitted to the rotor which is to be nounted in this casing. The projecting rows of impulse blades, will be fitted to the rotor which is to be nounted in this casing. The projecting rows of impulse blades on the rotor will dovetail into the spaces

To man, a building is suck a familiar thing that he seldom pauses to think that its strength from sidewise directions is far below its vertical strength (against gravity). In non-seismic regions this is adequate, but in earthquake areas horizontal forces about half as strong as gravity may occur. The best answer is to provide a much heavier system of diagonal braces. This requires altering hun habit, custom, tradition—a slow process



Pluto by Ben S Hears

$\operatorname{Earthquakes}\operatorname{Need}\operatorname{Not}\operatorname{Kill}$

THERE was no warning, only a deep and terrible roar, and in four seconds the town of Pegu in Burniese India lay in ruins, destroyed by an earthquake. Before the frightened inhabitants could ruin a single step their flimsy city had buried them.

The earthquake is the swiftest and most grgantic manifestation of power ever seen on the globe. It dwarfs volcanic eruptions, hurricanes, even the most deadly of man-mide explosions such as the Halifax disaster of 1916. It may mother thousands of cubic miles of solid rock, change hundreds of miles of geography, shift mountains, rearrange rurers and harbors, create lakes or destrey them, open miles-deep cracks in the ground and grind millions of tons of rock to powder—all in the winking of an eye.

Before men can even tell which way to run it is all over-buildings are down, hundreds or thousands dead, cities in flames. The tremor in Southern California in 1933 lasted only seven seconds but killed 120 people. In San Francisco 40 seconds sufficed to start the ruin of a metropolis. In Chile a little while ago the shake went on for two minutes; 50,000 died and as many more were injured. Through the pages of history runs a red trail of blood and fire to mark where man, the luckless interloper, has gone down before the onslaught of the laboring earth. Lisbon, Messina, Port Royal, Charleston, Tokyo, Helena, Chillan-the record is jammed with tragedies. One moment a teeming city, the next a shambles, like a Sodom and Comorrah struck down by divine wrath.

Yet earthquakes are not "acts of God"

A Small Percentage Added to Building Costs for Adequate Bracing is Changing Earthquakes from a Dreaded Horror to an Interesting Phenomenon

By DAVID O. WOODBURY

at all. They are as normal as rain and far more frequent. Mother Earth twetches constantly lake a sleeping dog and cares no more for the effect than he. Sciamographs distributed throughout the world record an almost steady shiver of the ground—too minute to be felt, mostly, but proof of incessant activity below. In an average year Japan is visited by some 12,000 tremor, with other countries around the Pacific basin playing close seconds.

NOR are major quakes uncommon either. There are on the average 50 of them every year throughout the world. In Chile severe shakes occur every month or so, often accompanied by destructive seismic sea waves. Even in solid old New England there have been 350 earthquakes of major intensity since Colonial times. Earth tremors are as obedient to the law of averages as the cycles of the weather. In dangerous areas, such as Japan, Southern California, and South America, seismologists keep a continuous record of the uneasy earth and can foretell the probability of future quakes as accurately as an insurance company can predict the life expectancy of a

Earthquake disasters usually overtake

the public without warning, but scientises are rarely surprised. Seismologists in Southern California, for example, are momentarily expecting another major shake, with an intensity say great, possibly, as the one which wrecked San Prancisco in 1906. It may come tomorrow, it may not come for years. But they know that it will come sooner or later. Whether a great disaster will follow, as in Chile, depends upon where it strikes and how much protective work has been done in the meantime.

For people do not need to die when the earth shudders, nor do cities need to be trilned. The earthquake, says the scientist, is rarely destructive in itselfi. It is man's persistence in building inadequately—his refusal to eliminate the death-traps that he has deliberately exceeded from the structure a public both to face the simple engineering faces. Little by little it is convincing the people that if they must live where continents are still in the making they must realize their danger and prepare.

A long and difficult problem of education this is, and one that must be founded on an exact knowledge of earthquakes and of how and where they strike. Admittedly, protective seismology has only just begun. Fifty years of research has meant no more than a start.

Though the effects of the shuddering earth are gigante, the causes are most difficult to find. This is because they be of far down in the bowels of the earth that they can never be studied at first hand. Only the comparatively minine vibrations which reach the surface can be used to interpret what goes on underneath. Ironically, man's entire knowledge of the deep interior comes from a study of the tremos which destroy. Without them he would know luttle of the depths below a few thousand feet.

Earth has a solid crust 20 to 40 miles thick. Unlike the crust of ice on a pond it does not float on liquid material helow it, If it did, carthquake vibrations would not be transmitted as they are through the center of the globe A few miles down science pictures the pressure and temperature of the overlying rock to be so tremendous that the material is actually made plastic, like tar in a bairel. On this, geologists think, the hard outer shell slips and slides like scum in obedience to forces unknown Erosion, the gradual shrinking as the interior cools, the release of radio-active energy, the tidal pull of the Moon-any or all may be the fundamental causes, no one yet knows But the effect on top is certain. The thru hard crust on which we live is subjected to continual twisting and bending, stretching and compression, and is tortured into ridges and hollows as it tries to accommodate itself and fails. The result, as seen by the inhabitants outside, is the mighty process of mountain building.

IT takes many millions of years to create mountains from a plan Surface movements may be unperceptible within the lifetime of one man, yet in accumulated centuries they are hige. The Himalayas themse lives were presumably made that way The important fact is that the earth's crust is never allowed to result to the ore and over and over allowed to read plant intensity no rock can stand then all at once something lets go, and the fringes of whole continents may move of whole contensits may move

Eons of this abuse have ruddled the carth's crust with fissues which run down 20, 30, even 40 miles. These are known as "faults"; they do not show on the surface like knife-cuts in home-made candy, but are filled in with pulversor orek and debris and often only geologists can recognize them. The great San Andreas Fault in California is largely hidden, and is principally identified by mountain structures which have been rent asunder and moved past one another as much as 20 miles.

Mountain building is mainly vertical but the strips of land between faults are moving horizontally also, and at considerable "speed." The friction of two neighboring blocks of crust is very large and as they try to slide past each other they stick fast and cannot move. Gigantic stresses are built up and the loose top layers of sand and boulders along the fault are actually compressed and sprung out of shape as if they were made of rubber. A fence or road across a fault often shows this condition by being bent into the form of an "S" When friction can hold the pressures in cheek no longer there is a roar and a shudder and whole cubic miles of rock spring into life and jerk past each other. The forces are so huge that these "clastic rebounds" invariably overshoot the mark. The earth then jorks and jerks again till the strains are for the moment eased. This is an earthquake: no wonder, then, that luckless human witnesses and their puny buildings are often destroyed!

BUT the actual slip along a fault is not in itself the destructive element. It is the aftermath of vibration which does the harm. If all the cities in carthquake zones could be built on solid rock there would be no disasters, for the rock itself shakes only a fraction of an inch The danger lies in the deep deposits of alluvial soil which skirt the mountain walls. The loose rocks and sand are saturated with ground water and the conglomerate acts like a jelly, intensifying every earthquake vibration to hun dreds of times its original amplitude Thus the principle of resonance, which is so useful in a radio set, in carthquake country becomes the sinister devil which destroys everything in its path.

There is always a center of disturbance on a fault where the actual slip begins. It is usually miles below ground and the movement may not reach the sunface at all. But the vibrations do, and they apread out in every direction, often traveling clear through the cartin and out on the other sade. The whrations come in three disturb. parts: first, a high-frequency wave which is too fact to be felt, but which shakes the air so rapidly that



it creates the horrible roar often heard just before a quake. Next, a vibration of nuch lower frequency which rattles dishes and chandeliers but does little harm. And finally, the slow and deadly set of waves, traveling like rollers in the occan along the surface of the ground.

These are the ones that fling the trees about as if in a great wind, open and close huge cracks in the earth and send people staggering and often deathly seasek as they go. These are the ones that set the buildings rocking and topple them down on whomever is in their path,

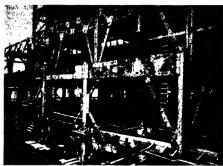
Science bases its entire knowledge of carthquakes on studies of these vibrations, transmitted through the earth and picked up by delicate seismographs hundreds or thousands of miles from the center of the disturbance. In principle the seismograph is simply a heavy weight suspended like a pendulum, holding a stylus against a piece of smoked paper. When the earth piggles the paper jiggles with it while the weight stands still and thus a record of the vibrations is scratched on the sooty paper. In highly refined modern instruments the recording is done electrically through vacuum-tube amplihers and a beam of light on photographic paper.

The successful analysis of an earthquake depends upon how accurately the center of disturbance can be located in the earth. This is a problem of triangulation in three dimensions and requires a detailed interpretation of vibration records taken simultaneously at widely separated points. A network of seismo-



Courtesy Lapiscottan News-Henord
Above: Earthquake provinces of
California, Note San Andreas Fault,
Left: Lines show zones of carthquake origin in the northeast, an
area by no means safe from quakes

graphic stations is gradually being built up all over the world and a central computing headquarters has been established in Oxford, England. Records are constantly flowing to this station from everywhere and the data are correlated so as to give the position of each important earthquake as it occurs. But it is a long and



outer General Electric Company
Showing what is meant by adequate diagonal bracing against earthquakes. The
Edison Building in Los Angeles with steel frame and arc-welded seismic bracing

complicated mathematical job and sometimes years clapse before exact results on any one tremor can be published. In the United States similar work is done in Washington and St. Louis.

In localities of high earthquake danger, such as Japan and California, much more advanced measures have been taken, and well-staffed central laboratories are maintained, surrounded by a network of recording stations located with special reference to the existing faults. The work of these organizations ig gradually making it possible to predict where earthquakes will occur and to show how protection can be achieved

SEISMOLOGISTS drude the world into two narrow earthquake belts, one circling the Pacific Ocean, the other raining across. Europe and Asia from Spain to the Orient. Minor belts are found along the eastern seaboard of the United States and in the Missivsippi basin. At any point within these belts destructive quakes may occur at any time, and there is no positive assurance that they won't occur outside them also.

Disastrous tremors are uncommon in America except in the far west, although plenty of strong shakes have been record-cit the good-goal formation in the cast is the most ancient in the world and its worst shaking was over before man arrived. The middle west is almost as stable Nevertheleas, the greatest quake in American history took place in New Madrid, Missouri, in 1811, and only missed killing thousands because it happened in the wilderness. Nevth Dakota is the one state where a destructive quake has never been recorded. There is no guarantee that even that will escape for-

New York City is virtually immune,

for it is built on two deep and aged rock strata untroubled by faults Boston, on the other hand, is not far from the great Fundy Fault in the Gulf of Maine, and major shakes have occurred there. The hazard is considerable, because the whole Back Bay section of the city is built on muck pumped from the Charles River, A quake as severe as the one that struck in 1755 would probably cause severe damage and heavy loss of life. Philadelphia, Chicago, and many other large centers are similarly book on made land, which is ideal shake material, and might suffer severely even in a nunor earthquake Charleston, South Carolina, was badly damaged in 1886 by a small disturbance because it was built on poor foundations Nevertheless, the risk is considered so slight in the eastern half of the United States that almost no one ear-11cs earthquake insurance. In the whole city of New York, for instance, only a scant handful of buildings are so covered.

By long odds the greatest danger point in America is in Southern California and it is here that a typical earthquake program is being built up. The work centers around the Carnegie Institution's seismographic laboratory at Annandale, with assistance from the Coast and Geodetic Survey and the laboratories of various universities. Intensive study was begun after the San Francisco disaster but it got little support from the public till their bad fright at Long Beach in 1933. Since then the Earthquake Commission has become an accepted institution and has made use of every opportunity to urge utmost preparedness against the serious earthquake which is surely com-

Numerous seismographic stations are scattered about the state and their records of vibrations are ingeniously synchronized by photographing radio signals alongoid the tracks drawn by the tremors themselves. From these timed pute the direction from which the vibrations come and their speeds, and hence to keep informed of the slips occurring on the seven faults that cross the state. The government, also has erected a large number of monuncuts or bench marks on high ground and these are surveyed annually to indicate the general movements of the earth

WHENEVER a major earthquake occurs, most of the delicate instruments nearby are put out of commission and information has to be gathered from such random sources as the direction of fall of gravestones, the pattern of cracks in the soil and the movements of buildings and their contents. Though eyewitness accounts are highly unrehable, a postcard poll is usually taken with the hope of obtaining enough data to form reliable engineering opinions. After a serious quake one man sent in a sketch of the wandering course of the gas stove around his kitchen floor It gave the scientists an excellent picture of the earth movements at that spot in the devastation area. Recently, "strong motion" instruments have been installed around Los Angeles and hit or-miss observations are no longer so necessary

But these scientific studies, valuable as they are for the future, do not interest the citizens as much as the campaign for protection which the Earthquake Commission is also fostering. The last serious quake, at Long Beach, occurred just before six in the evening. If it had happened carlier thousands of school children would have been killed, for not a school for miles around was left undamaged and many were destroyed The public instantly clamored for advice on how to rebuild their schools so that they would not fall again, and with the help of the chambers of commerce and insurance companies, a rigid building code was worked out and passed by the Legisla-ture. Every school in California has been rebuilt or strengthened since; in Los Angeles alone it is estimated that \$150.-000,000 has been spent,

The rule for building protection is simple but often expensive, make them heavy and rigid and te them to firm foundations. A slack is destructive because its third type of vibration closely coincides with the natural period of sway of the average building, Heavy, willowy buildings especially are prone to fall in step, and their own elasticity amplifies the motion until they collapse. Large reinforced structures usually do not topple themselves but send tons of ornamentation in a deadly shower to the street. Property owners are warred not to decorate their buildings with anything that can be shaked noose Civil engineers are

EARTHQUAKE RISK IN CALIFORNIA

that question with any definiteness. A great shock may come soon, or within a decade, or not till after more than a decade. But it will come

I have been asked what I would do in the circumstances and I have answered that I would try to do the sensible thing I would see to it that my house was reasonably well tied together so that my family might sleep and live in security, and I would endeavor to arouse public interest in demanding that school buildings, stores and other structures were made safe also against wreck and fire hazard. And I would take out earthquake insurance

San Diego District San Diego and Los Angeles have so much in common in their earthquake history, it might at first sight seem appropriate to describe as one province the whole coastal plain, together metal-moniquant ranges that rise from the same of the same

A prophecy shich caused a rumpus, and its happy aftermath, When, in Docember, 1923, the nord seismologist Prof. Bailey Willis, of Sanford Unnersty, published in the Bulletin of the Sessmological Society of America the warning in the top two lines of the reproduction above, and the advice in the succeeding seven lines, incensed real estate men rushed to the head of Sunford University and (unsuccessfully) demanded recantation or discharge. Ten years later came the first major quake, Long Beach (Prof. Willis predicts another), and this made it possible for science again a long-denied hearing. A joint report of science and business (see below) was issued and and buildings were begun. Before buildings an hea altered, human traits must be altered—the bagger take.

To the Public:

In response to official requests from many representative technical and covic organizations, the Joint Technical Committee on Earthquake Proceetion was organized after the earthquake of March 10,1933, to consider ways and means of minimizing loss of life and property damage in the event of another earthquake of equal or greater intensity.

We now present to you, in the form of this summarized report, our belief as to the estimic hazard in this region and our opinion as to the proper shalince between the degree of protection to be afforded life and property and the cost of providing such protection.

We sincerely hope that the lessons of the Long Beach carefulake will not be forgotten as were the lessons which should have been fixed indelibly in the minds of all by the earthquakes of the past

JOINT TECHNICAL COMMITTEE ON EARTHQUAKE PROTECTION

bent a Milerk

asked to design the columns and foundations of new structures so rigidly that their natural period of vibration will be much faster than the earthquake's tremor. Buildings of this kind in Tokyo came through the holocaust almost untouched, but in Chile whole cities built of spineless adobe and brick were ground to powder, the inhabitants beneath Small homes of wood are unusually sturdy for their weight and rarely become death traps. They may be thrown sakew on their foundations but are likely to remain in one piece. As for personal conduct during an earthquake, say the scientists, the first requisite is to avoid panic. The victims are hiely to be the people who rush screaming to the street only to be crushed by falling debris. The safest place when the shake begins is a solid arched doorway or an inside corner of a room that is well braced. Most natives of California and other danger spots know this, but by no means all of them practice what they know when the horror begins.

An important point to remember is that a severe earthquake is aure to be followed by after-shocks, some of them nearly as severe as the original. People who have dashed into the ruins to save victims are often caught by the toppling of huildings weakened but still standing. Thousands in Chillán met their death in this way.

OPEN flat spaces are usually the safeat, for trarely does the ground "open and awallow men up," as it was reported to have done in San Francisco. But open spaces in the hearts of cities are to be matrixed. In the Tokyo quake 40,000 homeless people were herded by the Chief of Police into a broad park especially maintained for this emergency, thruging with them what few belongings they could snatch from the ruins. Within a few hours they were surrounded by flames, their tinder-dry baskets of clothing caught fire and they were incinerated to a man. The Chief of Police committed harskiri that same night, from remores.

In many earthquake countries people firmly believe that shakes do not come without warning. There is still a dogged faith in signs such as "earthquake weather." Seismologists find some justification for this but warn that actual predictions of time and place are surely the work of charlatans. In Japan, sometimes, low barometric pressure and high winds precede a quake, If there is any connection it is because the earth is in so critical a state that wind pressure against the mountain walls is enough of a "trigger force" to set the quake in motion. Occasionally, a few minutes or hours before a tremor, the land will begin to tilt slowly, but quite as often the land does not tilt, nor does the weather give any sign.

Far better than believing in signs is to work for preparedness. The responsibility for this lies mainly with the city governments, which must learn to face the menace of earthquakes regardless of civic pride. To let quake protection lag is misplaced economy; worse, it is an open invitation to disaster. Nor is a thoroughgoing program of protection prohibitive. As the noted engineer, R. R. Martel, said in addressing a Los Angeles meeting recently: "iff you will put only 10 percent more into the cost of your buildings, the chamber of commerce can adopt the slogan: 'Come to California to enjoy the next earthquake.'

TINTED LENSES

Sun Glasses Should Give Adequate Protection Yet Maximum Visibility . . . Objective is to Eliminate Rays Which Do Not Contribute to Seeing

Euron's Norts, Increasingly nule use a unglasses to eliminate glare, especially jor sports and automobile driving, makes necessary a utaring that only certain types and colors will gue the protection that is sought, in the following article are summarised the reasons for tecaing such glasses, what they must do to be effective, and the types that nill be most effective for use nith normal eyes.

TIKE other organs of the body, the Jeyes have had a difficult time keeping pace with the rapid strides of civilization. We have turned night into day, giving the eyes little rest from the continuous bombardment of light, Although the eyes are about as adaptable as any other organ, they have a great variation in sensitivity. The deposit of pigment in the choroid, retina, and it is is as variable as are the human races, yet has a definite relationship to a person's tolerance of light. By adding pigment to the eye in the form of a tinted lens, the enhanced sensitivity of the nervous conducting mechanism of the eye is allayed There are many pathologic and psychogenic states which respond to an absorption lens of the proper pre-cription There are numbers of tinted lenses on the market, many of which are offered without any pretense of -cientific co ordination with the eve.

The normal eye soes primarily with

the yellow and yellow green components of the spectral light—the most humanospari of the spectral mand the one in sharpest focus in clear words when in exact focus for the yellow, the eye is slightly out of focus for the extremes is slightly out of focus for the extremes processing the spectram, the red and violet. Docomfort may result from sharp focusing of either of those extreme rays on the sens-tive layer of the retina and a tinted lens of the neutral type may remove these rays entirely of diffuse them. A neutral type is one which absorbs equal proportions of all colors of light, as opposed to selective absorption of certain radiations.

PERSONS with normal eyes who wear absorption leaves for summer glarer usually more confortable with one of the greensh types of optically ground and polished leaves whose properties are definitely established and the three messes of which are held within close limits. Since the maximum of the visual response is in the yellow and yellow green portion of the visible spectrum, a lens which transmist these radiations will give the unitoot that may be expected in visibility with as little light loss as is possible with adequate protection.

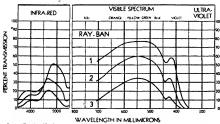
A few types of these glasses are not able for their elimination of both the ultra-violet and infra-red radiations, neither of which contributes to seeing. The dangers of these two radiations are well known in industry and they are



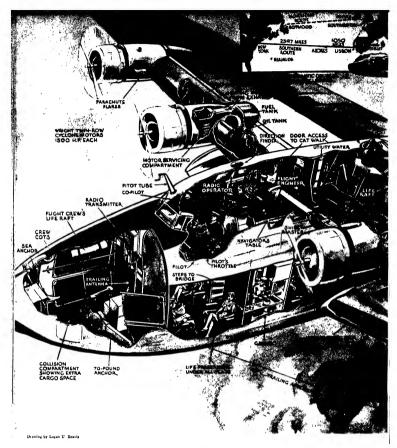
suspected of contributing to several occular diseases but their exact effect in sunlight is still a subject of study. Infraed radiation produces heat and one is warned by the burning sensation felt in the eyes Most of the illitraviolet radiations are helieved to be stopped in the cornea and crystalline lens, but any effect of them is the more misdious because the reaction is not felt for house.

Yellow-green and blue-green glasses appear to merese visability by bright-ness-contast, due to the climination of seattered light of short wavelengths, just as a photographer obtains fine pre-tures of clouds and distant scene by brotographer gets sharp photographes gets sharp photographs of enormous stretches of country by using a fifter which excludes all but the inflar red rays. All those devices function large-light scattered by the moving effect of short-wave light scattered by the intervening atmosphere.

The various tints of glasses on the market result from the kind of oxides added to the glass-forming constituent, usually a soda-lime batch, Cobalt oxide produces a blue glass, chrome and uranium oxides, green glass, gold oxide, ruby, silver oxide, yellow, manganese oxide, pink or violet, and cerium oxide, brown All of them absorb different portions of the spectrum. Amethyst glasses have a strong absorption in the blue icgion and modify colors to a great extent Amber and brown glasses absorb the blue and violet, flatten the yellows and intensify the reds, but their transmission of infra-red is high, Blue glasses of the cobalt types absorb selectively in the green, vellow, and orange-red. They also have high transmission of the infrared. Crookes glasses, brought out in 1913 by Sir William Crookes, were a great advance over previous absorption lenses. definitely absorbing both the ultra-violet and infra-red rays. Although widely prescribed today they are not so popular as formerly, due to a marked selective absorption in a narrow band of the visible spectrum, caused by the use of the rare arth, didymium, In the darker shades they absorb heavily in the region of maximum visibility



watery Bauch and Loub Light teansmission of one type of sun-glass lens, in three different shades. Note high percentage in visible, low in infra-red, and opacity to ultra-violet

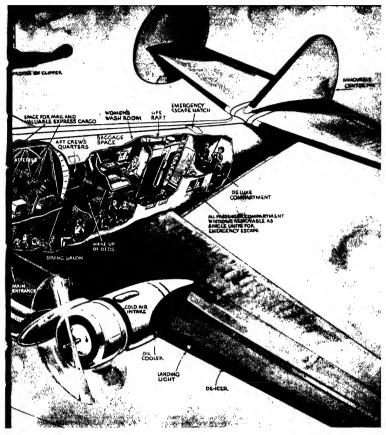


In the Transatlantic Service

WITH wings spreading 152 feet and hulb 106 feet long. Beeing Clipper ships have inaugurated transatlantic airmutal service, it is expected that, by the time this issue reaches the reader, transatlantic passenger service will have been established on regular schedule. Afteady six of these large ships have been built. Two of them are in use over the Pacific, while the other four are to be used in the Atlantic flights Our drawing shows the details of these ships, which have been designed to offer the utmost in confort and safety.

to the passenger. When used for daytime flights, 74 passengers can be carried; berths made up from triple-seat davenports will accommodate 40 passengers for night flying. Sound-proofing is extensively used throughout the Clippers,

sound-proming seximisively used inroughout in the clippers, or erew quarters as well as in passenger compartments. Air conditioning assures comfortable temperatures at all times. A completely equipped galley serves hot meals while aloft. Designers of the Clippers have foreseen every possible mergency and have made privisions for insuring the safety



of passengers and crew at all times. Individual life preservers are placed under all seats; life rafts, each capable of supporting Dersons, are radily available when needed. A kite, stored above the after crew's quarters, can be used as a signaling medium in case of a forced landing. Complete fire-fighting equipment is provided.

The inset map at the top of the drawing shows the two rought of the top of the drawing shows the two forces. It is possible, however, that, due to weather conditions and the desirability of taking advantage of favoring winds, deviations from direct courses will be a matter of routine when transatlantic flights are on regular schedule. In fact, on one of the first mall flights, the Yankee Clipper, first of the ships to fly the Atlantic, made a 300-mile detour to the south of her normal course when adverse winds were encountered. This detour made possible a stop at Bermuda.

More technical details of the Boeing-314, as ships of this type are known before they are christened, will be found in issues of Scientific American for July 1938 and May 1939. As is usual in the design and construction of new plane types, changes have been introduced as work progressed and it was found that such changes would be advantageous for one reason or another. For example, early plans for the Clippers did not call for the immovable center fin of the tail assembly. In fact, test flights were made without it and it was not m-stalled until experience indicated that it would be desirable.

McDonald Observatory

THERE is no more successful example of human co-peration than is found in astronous. Here, at least, the rule of reason prevails. Our political, national, and racial differences, however important, have really very little significance beyond the limits of the Earth's atmosphere. Here we cannot act or experiment, but must be observers only but we may still be active observers, seeking eagerly for the best opportunities and the most powerful means of unestigation

Many kinds of co-operation among astronomers are an old story, such as the division of a great field of observation, such as cataloguing the stars, into parts undertaken by different observatories; and the continual exchange of information, published and often unpublished, is the very life-blood of our growing knowledge. The smaller institutions, in particular-as the writer of these lines has abundant reason to acknowledge with gratitude-are continually indebted to the great observatorics, which, gathering information far faster than the photographs can be worked up, are most generous in supplying material for theoretical workers clsewhere.

A new and very effective type of cooperation has just been formally inaugurated in the principal astronomical event of the past month—the dedication of the McDonald Observatory.

Forty years ago, Mr. William J. Mc-Donald, a hanker of Paris, Texas, became deeply interested in astronomy, as 1926—leaving no near relatives—he left the bulk of a considerable fortune to the regents of the University of Texas "for the purpose of aiding in erecting and equipping an astronomical observatory, to be kept and used in connection with and as a part of the University, for the study and promotion of the study of astronomical science."

When certain legal problems were settled, the University bound itself in possession of about \$800,000, and a major problem arose. This sum was enough to provide for the construction of a really great telescope, and equip it with the accessories required for modern research; but if this was done, there would be very little left to provide salaries for astronmers to observe with it. If enough endowment were set aside to provide for an adequate staff, only a telescope of moderate capacity could be built with the remainder.

Rather than suffer this limitation, it was at first planned to let the fund ac-

The Large New Observatory in Western Texas Was Made Possible by an Amateur... An Admirable Site, An Efficient Housing and a High-grade Telescope

By HENRY NORRIS RUSSELL, Ph.D. Chairman of the Department of Astronomy and Director of the Observatory at Princeton University Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

cumulate until it became adequate. But, at the same time, the University of Chi cago found itself facing a similar, yet currously different problem The Yerkes Observatory was rich in staff, and less so in equipment. Under the new director. Dr. Struve, a very able and enthusiastic group of young astronomers was being assembled. The great refractor of the Observatory-the largest in existencehad been built when the possibilities of great reflectors were not yet appreciated. Indeed, it was the construction, shortly afterward, of the 24-inch Yerkes reflector (the first to be equipped with a mounting conforming to modern standards of accuracy and convenience) which brought the reflecting telescope back into its own. A great reflector was badly needed to extend the equipment of the Observatory; but there was no money for it.

SOME genius realized the complementary character of these two problems -each was the solution of the other. With the enthusiastic approval of President Hutchins of Chicago, and the late President Benedict of Texas (himself an astronomer) plans were developed for a close co-operation between the two universities-culminating in a formal agreement covering a period of 30 years According to this, the University of Texas was to build the observatory and the University of Chicago to staff and operate it-equitable arrangements being made regarding running expenses, and publication of the results. This close partnership between two independent institutions-one a state university, the other privately endowed-is a novelty. and promises great things.

The next problem was to find a site for the new observatory. Fortunately, Texas is a large state, and its western portion extends into the semi-arid region where high altitudes and clear sixes may be found. After the usual extensive reconnissance, a site was chosen on Mount Locke, in the Jeff Davis Mountains, in the county of the same name, The peak 17 6800 feet above the sea, with slopes not too steep to allow a well graded road to be built to the very summit, and covered closely enough with trees to protect the ground from overheating by the Sunsappear of the steep to t

The necessary conditions of habitability are therefore met—and well met. It is a cattle country, of good-sized ranches. (This phrase has a special meaning there—one may hear a cattleman say: "Oh, he hasn't a big ranch—only 80 sections.")

The observing conditions are also excellent. The seeing is good, the air clear,
and the site as sermote from city lights
and man-made glare as could easily be
found. From the summit the view ranges
in all directions over wooded mountains
separated by tawny grass-lands, with
hardly half-a-dozen human habitations in
sight. Long before the great telescope
was erected, Struve and Elivey had proved
the advantages of its location by observations of the spectra of faint diffuse in
building and of the brightness of the
2ddiscal light, and the faint diffuse illumination of the night sky—which could
only be successfully accomplished in the
clearest and purset of skies.

The Observatory itself crowns the very summit. A glance at it—or at a picture—shows one difference from most others. The walls of the cylindrical sub-structure below the dome are pierced with many windows. This reveals a very nice piece of architectural efficiency. To get the line of vision clear of the disturbed air near the ground, the great telescope is usually mounted at a respectable height, so that the floor of the dome is as far up as the third story of an ordinary house, in all their large observatories, the space under

this floor is simply vacant. Part of it may be used for constant-temperature rooms, and other scientific purposes; but most of it resembles the huge space below the dome of the 100 inch telescope at Mt. Wilson, which was once described as "providing ample parking space for the automobiles of the mechanics and the walking-sticks of the astronomers." On Mount Locke things are different The large available space is divided by floors. and provides for a library with stacks and a main room big enough to hold 80 to 100 people-it was crowded at the conferences!-also offices for the principal members of the staff, and several small bedrooms for astronomers who come down from Yerkes for special work The permanent members of the staff have houses on spurs of the mountain a little below the summit--and the writer cannot refrain from expressing his admiration of the good judgment which has made these houses really attractive

MOUNT LOCKE is remote enough to make it necessary for the permanent observers to live on the mountain. There is no near by town, as at Pasadena or Victoria, Living in a small isolated mountain community has some inevitable disadvantages. They are far less serious than they once were-no one who has heard it will forget the story of the young son of one of the astronomers at the Lack Observatory, who lay unconscious, after a bad fall, for three hours, while the doctor summoned by telephone toiled up the steep winding road as fast as a team of good horses could take him. Even today there are some moonveniences-but they count for less when the things which can be provided to make life pleasant are available.

But all else on the mountain centers, of course, upon the great telescope—the second in the world. The 82-meh mirror is of Pyrex glass- -of very low coefficient of expansion-and has been figured with almost ideal precision. Thorough tests by the veteran observer, J. S. Plaskett, show that the deviation of its surface from the true form averages only seven ten-millionths of an inch-one thirtieth of a wavelength of visual light. The "diffusion disk" resulting from the failure of all parts of the mirror to bring the light to precisely the same focus is considerably smaller than the diffraction disk arising from the properties of the light-waves themselves so that a still more perfect adjustment of the figure would gain nothing practically.

The mechanical mounting of so large an instrument is a difficult engineering problem—the moving parts weigh 45 tons. The "cross-axis" design has been dopted—in which the principal polar axis extends between two separate piers and the telescope tube is at one side of this, counterbalanced by suitable weights on the other.



The 82-inch mirror, 12 Inches thick, after aluminizing. From left to right: H. L. Gook, director of the Wainer and Swasey Company's instrument department; C. A. Rohert Lundin, director of the optical department, who figured the mirror; Dr. John S. Plankett, director emerities of the Dominion Astrophysical Observatory, who tested it, George A. Decker, works engineer. The food ratio is f.d.

This type of mounting has the great advantage that all parts of the sky may be observed-including the pole and the southern horizon Great reflectors, with mountings of this soit, existed already at Victoria, B. C., Delaware, Ohio; and Toronto, but the new instrument has one great advantage that these lack-a coudé device for spectroscopic work. When this is in place, a plane mirror, inclined at 15 degrees, reflects the light from the telescope tube at right angles, through the hollow declination axis, to a second mirror, which sends it down the interior of the hollow polar axis. It comes out at the lower end of this at the same place. no matter to what point in the -ky the telescope is directed. The rays are received in a room maintained at constant temperature, in which very powerful spectroscopes, and so on, may be intalled.

The 100-inch mounting at Mt. Wilson was designed with an arrangement of this sort, which has proved increasingly valuable and useful; but the engineering problem of adapting this to the cross-axis type of mounting had not previously been solved. It was necessary to alter the construction of the main bearings, about which the telescope is turned to reach northern or southern stars, so that, whatever its position, the light might have an unobstructed passage The unusual position of the great counter-weight at the upper end of the polar axis rather than opposite the telescope-bearing was part of the same scheme.

The instrument has also the usual Cassegrain arrangement in which the light is reflected back by a convex mirror through a hole at the center of the great mirror, to form a large-scale mage, and an ingenious device for taking photographs at the primary focus

in the middle of the top of this main tube—thus avoiding the loss of light by reflection at a diagonal mirror. The moving platform by which the observer may reach the upper end of the instrument in any position is also very efficiently designed.

The latest methods have again bein used in the "drive." which turns the great mechanism about the polat axis to follow the stars. This is entirely electric and regulated in rate by the precise and effective vacuum-tube control devised by Dr. McMahl. It can be adjusted so as to allow for the changing effects of refaction as the stars change their altitude, and the test of actual operation.

shows that it is "practically perfect."
It would be of little value to have
even so powerful an instrument if there
were not a good program of work to be
done with it. Here Dr. Siruve—now
director of the McDonald as well as the
'Perkes Observatory—has outlined plans
which should meet the hearty approval
of all astronomers. Problems which demand the utmost light-gathering power
such as to extend the boundaries of
our knowledge of the "universe of
galaxies"—are wisely left to the 100-inch
telescope, and the 200-inch when it is
finished

But there is an immense field of work in the study of individual stars, and especially of those unusual and interesting objects which are found here and there among the faint stars. With an excellent outflet of accessories—spectrographs and the like—the McDonald telescope has laredy, before its formal dedication, revealed new and important things. Its admirable site, its excellence of mechanical and optical quality, and, above all, the skill and optical quality, and, above all, make a long career of usefulness certain.—Princeton, June 1, 1939.

Under The Nieuwe Maas

AT an outlay of approximately \$8,225, 000, Rotterdam is building a subaqueous tunnel that differs radically from other structures now in use as underwater traffic routes. This single structure, which passes beneath the Nieuwe Mass River, is designed with four passageways—one for pedestrians.

one for cyclists, and two for motor vehicles. As an engineering undertaking, the tunnel is unique in a number of particulars. Work on it is now in full swing, and some of its main sections are in advanced stages.

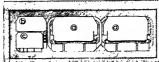
To appreciate why Rotterdam is thus equipping he self, one should have some understanding of the extent of this center of Holland's maritime commerce. The port is situated less than 20 miles

inland from the North Sea at a point where tributary river routes and various canals have made the harbor accessible to vast interior regions of Holland, Ger many, and Belgium. Rotterdam's social, industrial, and commercial expansion during recent decades has proloundly aftered her utra-urban traffic problems.

altered her intra-urban traffic problems. At this time, 30 percent of Rotter-dam's people, many of her foremost in dustries, and the greater part of her shipping interests are located on the south side of the stream which bisects the port from east to west. The old Willems-Bridge, built in 1878, still remains the

Unique Tunnel at Rotterdam . . . For Vehicles, Pedestrians, Cyclists . . . Rectangular . . . Sections Built on Land, Then Floated Out and Sunk in Place

By R. G. SKERRETT



(cross-section of under-river part of timnel in which all three classes of traffic will be accommodated Passages for motor vehicles at (a, a); eyelists (b), and pedestrians (c)

single crossing available to pedestrains which is, and street railways. That structure is now not centrally located in relation to the most active sections on the two sides of the river, and it is over taxed at peak periods of traffic. To some activate richel has been afforded by cross-river feriuse, but these have operating dawabacks. The city authorities have for vears recognized that one or more additional perinament crossings doubt be constructed; but the question was what and would best meet the requirements. Bridges, of course, have been considered as well as tunnels by the engineers.

tous of freight in oversease commerce, and the Nieuwe Maas, now familiarly known as the New Materwax, is threaded continually by ocean-to the ail of the state of the source of the sour

In and out of Rotterdam

there is moved by water an-

nually nearly 34,000,000 short

would halt and congest the flow of motor vehicles. A high bridge, with ample under clearance for the masts of any ships using the port, would require very long approaches in order to assure acceptable gradients for vehicles. Such a bridge would have to have a length of 25 miles, and its approaches would be too far inshore to be readily accessible to motor trucks, for example, plying hetween the docks on our side of the stream and distributing points on the other side The engineering experts, accordingly, decided in favor of a subaqueous tunnel capable of providing annually for the transit of 8,000,000 vehicles, and daily use by thousands of pedestrians and evelists.

THE route chosen for the tunnel cross-ing is some distance downstream from the Willems-Bridge, and is intended to link what is known as the Park section of the older part of the city with the Charlos area on the south side of the river, where it will have its portal close to the very busy docks. The tunuel will also serve as a link for much used motor highways leading to and from other important cities of Holland The low land on each flank of the waterway permitted the designers to keep the total length of the undertaking within approximately 4800 feet; yet the nature of the ground both on shore and in the bed of the river has presented major difficulties

The project may be subdivided into two open-cut ramp approaches; two land tunnel sections; two ventilation build-



Unstable soil in the deep trenches of the approach ramps made necessary use of large numbers of piles. Deep-well pumps are operated continuously to keep the trenches drained. Each finished ramp will be a great reinforced concrete trough

ings, one at the water's edge on each flank of the river; and a central suba-queous tunnel section, which under-runs the stream and which connects with the anderwater foundation structure of each of the ventilation buildings. The river tunnel has a length of slightly more policy of the slightly more policy of the slightly more of the tunneling, including one of the tunneling, including the substructures of the ventilation buildings, the undertaking will measure \$1.311. fore!

The land tunnel sections are heing built in deep open cuts, the foundations for the two ventilation buildings have been carried down to their prescribed depths at the shore fronts by means of pneumatic caissons, and the under-river tunnel will be assembled by what is described as the "sinking method" That is to say, each of the nine separate sections of the subaqueous tunnel is built up to a degree on shore, then floated out into the river for completion in a buoyant state and, when ready for final placing in the river, it will be towed to a point directly over its given site and sunk into a trench excavated in the river bed. The substitution of this procedure for the familiar shield-and-preumatic method of tunnel driving is because the soil of the civer bottom is too loose and sands to permit the use of compressed air unless the tunnel were carried much deeper to reach firmer subsoil Other subaqueous tunnels have been constructed in a measure along kindred lines, but even so, the Rotterdam tunnel represents some novel and very interesting departmes in mactice

THE two sections of land tunnel air designed only for the passage of motor vehicles, while the river section will provide for the passage of pedestrians, cyclists, and motor vehicles. The pedetitians and cyclists will enter and leave the river tunnel through connections leading to and from surface buildings adjoining the ventilation buildings adjoining the ventilation buildings.

Each of the nine units forming the under-river tunnel is a great reinforcedconcrete block that is perforated from end to end by four traffic passages and numerous lesser longitudinal chambers for the transmission of fresh air and the withdrawal of vitiated air. Each of these box-shaped elements has a length of slightly more than 200 feet, a width of about 81.25 feet, and an exterior height of 27.53 feet. The roadway in each of the two vehicular passages has a width between curbs of 19.7 feet-affording room for two traffic lanes; and the ceiling is 13.77 feet above the roadway. The pussageway for cyclists has a width of near-ly 16 25 feet, while the passageway for pedestrians has a width of about 14.34

To protect each of these reinforced-



A partly finished tunnel section being towed from the drydork, where it was built, to the finishing alp where it will receive the remainder of its consisted both. This yiew serves to give a good comparison of the section's size

concrete blocks from water penetration. it is to have a coating of welded steel 0.236 of an meh in thickness, covering both sides and the top and bottom sur faces. As an extra protection against corrosion, that steel is to be covered with a thin layer of concrete. The working schedule has called for the smultaneous construction of three such tunnel sections in the Municipal Building Yard at Heysche-baven When a certain stage of partial completion has been reached, the divdock is flooded, the sections are floated out into the river and towed to Waalhaven, where the rest of the work is done preparatory to sinking.

To make it possible to float the sections from the divdock and to shift them to the finishing slip, each section, after the concrete is poured to half height in the drydock, is sealed at each end with a temporary reinforced-concrete bulkhead, and closed along each side with a temporary timbered bulkhead—all the bulkheads extending high above the surface of the water and giving the section the appearance of a great rectangular harge. At the finishing shp, each floating section is completed up to full height by pouring the remainder of the concrete within complex forms, and other necessary arrangements are made to put a section in readiness for sinking. The end bulkheads of concrete will be cut through after the various sections are located in contact in the river-bed trench Wherever two sections are joined, they will be bound together by an enveloping joint of concrete-the concrete heing poured under water and within forms provided for that purpose. When all the sections are linked together beneath the surface of the river, then the intervening concrete bulkheads at the joints will be cut away, one by one, while the tunnel

sections are unwatered progressively Each section of the river tunnel will be handled by floating cranes and other floating equipment, and to give it deadweight to cause it to sink, it will be filled with water so that it can be lowered deliberately and precisely to its assigned location. When it settles in the trench it will rest on a temporary foundation con sisting of hydraulically controlled jacks which will hold it at its proper level. With that done, all depressions between the nneven bottom of the trench and the underside of the section will be filled compactly with sand jetted in under high pressure in accordance with a method recently devised. When all sections are firmly supported, the jacks will he withdrawn and the entire trench will be back-filled to the original level of the river bottom

To facilitate pedestrains and cycless using the tunnel, there will be installed in a building at each side of the river of our escalators, each of which will have a vertical travel of 55.77 feet. The because the continuental Europe not only for pleasure travel but in making the daily frip, back and forth, between the home and the place of business. Hence the special provision that is being nade in this under-treet tunnel for cyclests, Likewise, the moderate length of the tunnel will be a special provision that is being nade in this moderate length of the tunnel will be useful for the special provision that is being nade in this will be a special to the special provision that is being nade in this work of the special provision that is being nade in the special provision that is the special provision that the special prov

The actual building of this unusual structure is being done by a group of experienced engineers and contractors, for the time being known as Maastunnel Limited. The sehiof engineer for the municipality is Mr. J. P. van Bruggen, to whom we are indebted for much of our information.

FLINT FLAKING

The Amateur Workman, as He Practices, Can Progress in Days through the Same Stages of Skill for which his Ancestors Required More Than 100,000 Years of Gradual Invention

> By C. STUART IOHNSTON Department of Anthropology, West Texas State College



Figure 1: Indians mining flint at Alibates quarry From a painting by Gustaf Sundstrom

THE art of working stone into useful implements is perhaps the most ancient of human arts li dates back to the dim dawn of civilization more than 100,000 years ago, yet it is still practiced by primitive peoples in many parts of the world. One of the outstanding differences between man and his his ability to make and use implements of one kind or another. Stone implements are in many instances the only records that we have

of early human lustory. Thus man's carliest efforts toward accomplishment are recorded in the impressionable med-



direct blow from the hammer stone



Figure 2 An accurate method of positioning and placing a blow



Figure 4: The same principle applied on a more powerful scale

rum that he has left behind-stone artifacts or "fossils of the mind." On the basis of their study the earliest phases of human history have been sub-divided. We thus speak of the Paleolithic, or the Old Stone Age, and the Neolithic, or the New Stone Age. But even prior to the Old Stone Age there must have been a time, many thousands of years ago, when man was just learning through crude efforts that stone could be roughly fashioned into a tool. Artifacts of this carly beginning are referred to as Eolitlic-the dawn of the Stone Age. After the stone ages came the Bronze Age, and this in turn was followed by the Iron Age.

The ancestors of the American Indians are thought to have migrated into the Western Hemisphere from Asia, in Neohthic time, following the Glacial Period, and, though their culture reached a high point of development in several localities, and though metals such as bronze



Figure 6: Practice soon teaches shape and size of detachable flake

and a few others were used, the Indian was essentially a stone-age man when America was discovered by the Euro-

In several world localities the technique of working stone reached the distinction of a fine art, due perhaps in part to an abundance of fine raw materials as well as to the character and inventiveness of the workman. One of these localities was centered in Denmark and parts of Scandinavia, one was in Egypt, a third was in the Pacific Coast region of the United States, and a fourth in the Great Plains region east of the Rocky Mountains, Here Folsom



Figure 3: The same principle applied with an awl on a small scale

Man made fine implements of stone, and with them hunted animals that are now long since extinct.

One of the largest and oldest quarries from which the American Indian obtained his flint is located on Alibates Creek, about 40 miles north of Amarillo, Texas. Here the flint is of a characteristic red and grey color with an even texture, and is easy to recognize even in a small arrow point found, as some have been, hundreds of miles from its source. Even Folsom Man, himself, who is known only from a certain definite type of implement that he made, obtained much of his material from this quarry. Figure 1, from a painting by G. T. Sundstrom. represents the Neolithic workman mining flint at the Alibates location. The writer is indebted also to Mr. Sundstrom for the other illustrations in this article.

After man passed the long, crude stages of the Eolithic Period we find him manufacturing the first definite implement of the Old Stone Age, and, though still rough in many ways, it was unquestionably designed for a useful



Figure 7: How pressure, blows, or both may be used when necessary

purpose. This early tool, known in the Old World but not in America, is called by the French a coup-de-poing, or hand ax. This did not usually exceed six inches in length, and when held firmly in the hand it probably was an effective instrument for many purposes.

The hand ax was made from a nodule of finit by striking off rough fakes until the core reached the desired shape. This technique is important and characteristic of Early Paleolithic time. The same technique was continued into the next epoch, but with the difference that there was a specialization toward more varied types of tools. Later, the flake itself was worked into a tool by a process known as retouching, but this was applied only to one side. The next step was an improvement and greater skill in the art of resulting. The workman became more touching. The workman became more

proficient in the use of the awl in scaling off thin flakes of flint to achieve the desired shape and edge of the tool. Eventually we find that the entire implement was retouched. Finally, it was discovered that, by the proper application of a sharp blow from a hammer stone through the aid of an awl [Figures 2, 3, 4], flakes could be detached from the core more effectively, and that it also was possible to control the process to such an extent that long slender flakes



Figure 8: How the bone awl may be used for retouching a thin flake



Figure 9: Notched hone awl used for twisting off very small bits



Figure 10: Pressure flaking with an awl against a leather protector



Figure 11: Still another method-detaching flakes with aide of awl



Figure 12: Completed, and you'll be sure your ancestor was a mechanic!

could be produced with kinic-like edges, satisfactory for use without the timeconsuming process of retouching. These steps as outlined, though apparently simple, represent nearly 100,000 years in man's advance from the Lower Paleolithic through the Upper Neolthic, and are so definite that chronology in culture can be based upon them.

Contrary to jopular opinion the method involved in making stone knives and arrow points is not a lost art. Indeed, the the methods are rather simple, although considerable skill is necessary, and the worker will find that painstaking practice is essential before he is able to produce a pleasing product. The only required tools for arrow making are an awl, either of bone or iron, a hammer (for this purpose the Indian used a sustone), and a leather pad to be used as a protection for the hand from the sharp chips of flux.

THE first step in making an arrow point or a knife, or spear point is to produce a suitable flake from the material at hand such as obsidian, flint, or glass, as shown in Figures 5 and 6. This is then further worked with the hammer and awl to the rough outline in Figure 7. Now that the flake has been worked to the approximate shape of the desired implement the next step is the process of retouching In this the flake is held firmly in the hand (Figures 8, 9, 10, 11) in such a way that, by application of pressure from the point of the awl, thin scales of flint can be chipped from the edges over the surface of the flake toward the mid-line of the flake. Thus the flake is sharpened and thinned down to the desired shape, as shown in Figure 12. After the point is thus brought gradually into shape the notches for attachment are worked into the flint in the same way. First efforts will probably be crude and of the Old Stone Age type, but continued practice should bring the new craftsman with his ancient art up to the Neolithic period in which his work will be admired by others and a source of pride to himself. His respect for ancient man is likely to expand.



Lining up an Eastman removable whipstock-

By drilling dehberately crooked oil wells instead of straight ones, a young Oklahoman has added immeasurably to the dwindling oil resources of the world. H. John Eastiman, though told by engineers that it couldn't be done, showed them how drilling on curve and slant can outsut geology, put a subternaean cork in wild and flaming wells, and, by angling out under the ocean, open up to man a use huge new reserves of petroleum, intherto counted as beyond his power to exploit.

But Fastman's methods have also opened a gusher of legal controversy. If oil can be pumped from under no-man's land, the sea, sho owns at 2 "We do," say, in a confusing chorus, the operators who finance the drilling, the sovereign states in whose coastal waters at is done, and the Navy Department, speaking for Uncle Sam. Furrous controversy and legislation has the save holdly "annexed" miles out into the sheal waters off their shores.

This new method-which Eastman calls "Controlled Directional Drilling"offers to the oil industry dazzling vistas and undreamed of skills By making holes straight, slanting, or curving at will, drillers can follow geologic formations, avoid rock structures, go through faults and under salt domes. From one derrick and top hole a driller can probe under 20 acres. This new slant hole drilling makes available deposits formerly withheld from man and greatly cheapens and makes more thorough the exploitation of known fields. Because of its underground surveying system, well operators for the first time know where their bottoms are; and, in new fields, can plan spacing and drainage in the oil sand, instead of hlundering at it from the surface.

More Oil from

By UPTON CLOSE

Where oil is found under cities, buildings, parks, and cemeteries, Eastman's process can tunnel down at an angle from far enough away to make unnecessary such projects as putting the derricks on the lawn of Oklahoma's state capitol Most sensational of results' John Eastman has given the oil undustry its first (oncluve) means of controlling wild wells and extinguishing dangerous and shockingly wasterful burning craters

Thanks to Éastman, we can get some of that 70-0d percent of the oil formerly left in the earth when wells were "through." The driller can start from any point along his casing, plug up the borrebow that point and at small expense drill slantwise right through the casing pipe to a point at which the oil sand still contains enough pressure to make he oil flow. Or he can even turn a hole tor un within and parallel to the oil beard to right and train the sand drain the sand by grav-



Mup showing wanderings of an oil well, from surface (0) to full depth

ity. Vast low-production deposits hitherto commercially inworkable, and exhausted fields, such as those in Pennsylvania and West Virginia, may now contribute the "fluid of life" for man's productive and destructive activities.

Great economies can be achieved through the Estaman method by drilling multiple holes from the same derrok. Where oil lies under shoal water the advantages of this method are enormous. At Elwood, California, piers running out 2000 feet from shore bear traveling dericks which have bored wells eight feet six inches apart on the surface and several hundred feet apart at the bottom. This field, to expensive to exploit by previous methods, has yielded 54 million barrels.

Oil men wondered how Eastman would get straight steel casing into bent holes. Eastman had been so busy he had overlooked this problem. To the surprise of all, the pipe easily bent to follow the curving hole. Natural pressure and heat helped at several thousand feet down.

Untold petrolcum resources, hitherto guarded from man by the ocean, now he open to his use Much of the world's untapped ocean oil can be reached by angling out from shore. Where ocean floors shelve gradually enough to make piers or artificial islands possible, multiple curving wells drilled on Eastman principles can tap more of it. All along the shallow coast of Texas and southern California, where oil men once saw only fathom soundings, they now see dollar signs "Directional drilling" makes profitable the building of small islands many miles out in the Gulf of Mexico, It sug gests that many years can be added to the life of the world's oil resources by exploitation in the shoal waters of the Black Sca, the Caspian, the Persian Gulf, and Maracarbo, Venezuela's great mland sea. American oil geologists, according to whose past estimates we ran out of oil in 1924, in 1928, and again in 1932, will once more have to revise their predictions

FOR 5000 years, ever since the Chinese began drilling for salt with stone bits hung on hamboo ropes, men have been trying to drill holes straight. Even in America's modern oil industry this has been so nearly impossible that oil men still call a well "straight" if it is less than three degrees from the perpendicular And a three-degree deviation is enough to make a 6000-foot well find bottom anywhere within an area of seven



Short piers support rigs for drilling out under water along oil strate

CROOKED WELLS

Controlled Directional Drilling . . . Significant Advance . . . Adds to Available Oil . . . Offshore Pools Tapped From Land Rigs . . . Other Uses

acres, often drifting onto a neighboring lease or missing the oil sands entirely Wells have been so crowled as to require 800 feet more drilling—at \$10 a foot-than was necessary to reach the bottom level, others, though scientifically spaced 200 yards apart at the surface, practically interest and the surface, practically interest and the surface, and the surface of a mole indeer the lawn

Some 10 years ago, at Signal Hill, that black Golgotha of derricks at Long Beach, Cabfornia, hundreds of wells driven within each other's shadows were tangling as they went down, and owners were at law over subterraneau trespass Nearby, at Huntington Beach, nien were trying frantically with costly piers and artificial islands to tap the oil which lay deep under the sea. Young John East man, a salesman turned oil field "roughneck" by the depression, fresh from Oklahoma and unhampered by knowl edge of engineering, worked after hours on devices to make perpendicular holes To do this, he had first to make an instrument that would trace where holes were going; and, second, a tool to correct them to the perpendicular. With these devices, Eastman made it possible for the first time for an operator to tell exactly where his hole was at every foot of depth and to steer the new well constantly while it was being bored.



Steps in turning a drill hole with a knuckle joint. After the turn-out is made, the hole is reamed until large enough for regular drill bits

Then came his simple, brilliant idea, contributed to an old profession, as so often happens, by a complete nowice Why be content with correcting error? Why not precent though the ceiling of perfection into a new field? Why not apply the technique of drilling straight holes to the drilling of intentionally crooked ones—holes which would feel their way along the shart of strate, and detour around projections of hard cock?



How Alexander 1, 5000 feet deep, was killed by drilling a relief well. Explanation in text

Perhaps he could even angle out under the sea and reach those rich oil sands beyond the farthest Huntington piers!

Eastman and his young wife organized a company, put every cent into development of his tools, went broke twice in the first two years He gathered inventive young engineers and helped them to get patents in their own names, Controversies arose--- at one time he had 14 lawsuits over patents on his hands. It was tough sledding. But in 1932 he and his associates were able to set up a derrick on Huntington Beach and offer proof to a skeptical oil industry. Curving from the beach 4000 feet down and out under the sea, the well brought in more than a thousand barrels a day. One of the big California operators, the Wilshire Company, grasped the idea and took a chance. Result: A 5000-barrel well The rush was on. Ninety wells had curved away from Huntington Beach before the city and state authorities moved to bring order out



The relief well employed in killing a wild must be located a considerable distance a

of chaos and claim shares in this bounty from under the Pacific.

Two years later, a still more spectacular use of Eastman's methods took him out of Califorma and "sold" his system to the oil industry in general. This was the conquest of Texas most feared wild well," early in January, 1934, In the Conroe field near Houston, Texas, a well. known as Alexander I, had blown up from a -ubterrancan gas explosion. its derrick was demolished and the explosion formed a huge crater nearly 200 feet across and nearly as deep, boiling with oil and throwing off fumes as dangerous as

dynamite. The entire Control oil field, one of the world's largest, was imperiled. In addition, the Hamble Oil Company, owners of the adjacent leases, saw their wells failing white this one spewed forth 9000 barrels a day, which past experience showed could end only with exhaustion or conflagration.

A Humble official had beard of Fact. man's directional drilling at Huntington Beach. Eastman was called in, told that if he could hit within 50 feet of Alexander's bottom the flow could be checked Was that asking too much? 'I'll go to within 25 feet," promised Eastman, "and if I don't, you needn't pay." Humble's own people would drill. Eastman would boss. That settled, Humble made a strange deal with Alexander's owners It paid them \$300,000 for the privilege of trying to kill Alexander. If the attempt succeeded, the 15-acre lease on which Alexander stood should be Humble's, If it failed, Humble would get nothing. If



Alexander took fire after Humble started operations, the Humble company would be financially liable Since the only end to such a wild well known up to this time had been very unhappy, the boys felt they were taking Humble's 3300,000 against slight odds. No driller had ever that a bull's-eye 0.25 feet radius a mile below the surface, and in Texas slant-drilling was vall a "crays rideal".

First came the most elaborate use of fire protection technique in drilling history. A barbed wire barrier unequalled in no-man's land was built to keep sparkmaking men and animals out of the area. A battery of six boilers set at a distance sprayed steam continuously over the crater. Tanks of chemicals were ready to be turned into the steam to blanket the gas and oil lake with foam in a few seconds. Then a steel fire-shield was erected 400-odd feet from the crater's edge, the derrick put up behind it, and drilling begun. No one had bothered to chart Alexander with the new Eastman instrument as it was bored, and it was impossible now to put a cylinder down the erupting crater. Eastman surveyed neighboring wells and risked reputation, career, and money on the likelihood of the drift being similar.

CHECKING every hundred feet with his directional camera instrument (described below). Eastman began to show at his small invaible target a mile underground. He drilled straight down or 1500 feet, than on a carefully calculated ord-screw slamt. When, eight weeks later, a mile deep, he figured he was within wit feet of the bull's-eye, water under 1800 pounds pre-sare was pumped into the slant hole he was drilling. The falling of pressure showed that the water had been forced through into the bottom of Alexander 1. Within 24 hours the oil of Alexander 1. Within 25 hours the oil of Alexander 1. Within 25 hours the oil

well stopped flowing. It had been corked from the bottom with the weight of the column of water.

Eastman was "made", yet so impersonal are oil men that today the name stands for a method, not a man. Several oil men have told me that no such men as Eastman existed! Controlled drivettonal drilling, said they, was the general property of the profession. So it is! H. John Eastman presented it in detail at the World Petroleum Congress in Paris in June, 1937. in June, 1937.

Eastman has since done greater salvaging marvels than killing Alexander In January, 1935, he killed a burning crater for Sinelair in southwest Texas, boring 400 feet from the flame and ending within five feet of the hole

The top illustration shows drillers starting a survey instrument into a well. This complicated device, which the author explains, is shown in section at the "watch-face" table on which the instrument indicates the location of the drill hole at a given depth hole at a given depth hole at a given depth



at a depth of 2300 feet. The old well was sealed with concrete, the oil was pumped up through the new. In August, 1936, he extinguished a burning well at Silabee, Texas, the most spectacular conquest of a flaming "hell" in history. He struck its bore at 7000 feet depth from a surface point 800 feet from the fire. His process killed a fired well in Venezuela. He "reheved" a blown well in Roumania, making his only recorded semi-failure - his

cleid vent was below the source of presure. In most of these cases, he had to contend with failure of original drillers to survey their wella. But drillers are converted now. Recording of a well's position at every hundred feet of drill-pipe paid out is routine. The Supreme Court of California has established the legal authority of Eastman's surveying method. He and his associates are supervising jobs and instruments in the greatest oil fields of North America, the East Indies, Venezuela, the Argentine, Roumania. the Persian Gulf, Australia, and Japan. One of his praspective jobs is turning the Black Sea into an oil field—as soon as rwal empires settle the control of that region

The basis of his method is accurate knowledge of where the bit is at each hundred feet of depth, and ability to change its course. Eastman began with the primitive method, then current in the oil fields, of hanging a partly filled glass bottle of acid down the well and leaving it for 15 minutes. The said etched a mark along the fluid's top, showing the approximate slant of the bore. But it was also necessary to check the slant against true north in order to locate the well's position upon a survey chart. South African diamond miners had dangled gelatin floated compasses down their exploration wells Eastman and several young collaborators worked to combine these two ideas. At first they used an ordinary compass and fine pendulums to maintain a orizontal surface against which the angle of the casing could be photographed. Later they substituted a gyroscopic compass, which maintains true horizontal and true north undeflected by magnetized ores, lost tools, or easing pipe. This was found to be too large for best efficiency.

THE instrument that informs Eastman today is complicated, and amazingly meeligent. It can be seen at the Petroleum Industries exhibit at the New York World's Fair—a long, thun metal evhinder which contains electric batteries, a compass, a plumb bols, and a miniature camera loaded with graph him or Homm movie strip. Sealed against much and let down into the narrow darkness of a well, this device will photograph, either in single shots or at repeated intervals, the position of the compass and the angle of the wall of the well. These were the eyes that enabled Eastman to see his slanting way down to within five feet of the bottom of the faming well at Silseber, Texas,

All this must be encased in a mudtight cylinder small enough to follow a drill hit. This watch-like instrument has actually been put in a 3.5 centimeter diameter. Its length varies from five to seven feet. Eastman is trying to make it yet more spindling. Although not a professional mathematician, he has worked out little "watch face" trigonometrical graphs in the form of negatives upon which the miniature camera photographs, at one exposure, the shadow of the compass needle and an angle shadow. The driller needs no technical knowledge; a tank develops the negative and he reads the indicated graph figures and checks the result on his blue print. About 30 minutes suffices for the entire operation of dropping, raising, and reading the instrument. (Still another survey method developed by Eastman checks by the turns of the drill pipe.)

So much for the underground survey instrument, Compared with it, the tool to guide the boring bit is simple indeed. When Eastman developed it for keeping bores perpendicular, he called it the "correctional whipstock." Now it is called the "removable directional whipstock" It is a three- to ten-foot-long hard steel shield looking somewhat like a grooved banana, fatter at the bottom than at the top, and ending with a sharp point The point-at the end of perhaps several thousand feet of drill pipe--is jabbed stock is hung around a drill pipe by a collar just above the bit and is lowered and fixed in position at the angle desired. Then the drill pipe slides down through the collar, the bit follows the slanting groove and is deflected off through one side of the hole. As soon as the slant bore is long enough to guide the bit forward without help, the bit is drawn up, catches the whipstock by the collar and lifts it to the surface where it is detached until the surveying instrument shows that it is needed again for the next deflection

A second tool for bias drilling has since been developed by Eastman and his associates: the 'kinuckle' joint,' which is just a drill bit operated by universal gears and louking like a giant dentist's drill. Before lowering, it can be set to start horing at a given angle. Eastman's preference is still the whipstock.

RAMILIARITY and skill are, of course, the secrets of the successful use of these instruments. You have to know how they behave in different strata and at different algels. You must know that up to a certain speed of revolution the bit drifts right, and beyond that it drifts left, and that it tups and piecres at a right angle through hard, alanting strata—unless the slant is too great when, on the contrary, it slips along it and leads off in the other direction. And there are a thousand other tricks.

Before Eastman came along, no state or nation had much reason to be concerned with submarine oil rights. But his discoveries have produced controversy and melodrama which are national now, will perhaps be international tomorrow.

Soon after the California gold rush, a community of Spiritualias settled on the Californian coast south of Santa Barbara, and named their haven "Summerland"—their word for the world after death, for Paradiae. Their placid beach was occasionally soiled by oil seepage, recognized by members from Pennsylvania where petroleum exploitation had begun. Scruples about tampering with Mother Earth were eventually overcome through the assurance of friendly ectoplasms. "Spiritus" guided fife enterprise of the com-

munity's Colonel Wayne Darling in putting the first oil well in the world through ocean water in 1896.

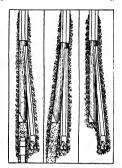
It, and succeeding wells, out as far as 1000 feet from the mark, became California's Eighth Wender of the World They were more successful as tourists attractions than as money-makers, and the contury, hard-hosted "back too fit the contury, hard-hosted "back too fit the contury, hard-hosted "back too fit the contury, hard-hosted "back to fit the contury, which successful to the contury, which catter of the other world and destroyed the character of the community. Wildcatters exited upon the under-water drilling idea and applied it in the rish fields farther down the coast at Huntington and El-

Then came Eastman, at Long Beach, pioneering with his curves out under the ocean floor The local politicians, who had thought no more of oil under the sea than of gold on the moon, became excited over wells put out into the harbor from Ford's and Standard Oil's waterfront fills. The city had granted the waterfront sites for factory and dock space -not for oil wells. This case is still in the courts Next, the California State Senate, led by Culbert L. Olson, accused corporations of taking untold wealth from state domain without benefit to the people. Two-linndred-odd wells are drawing oil for 80 corporations from under six miles of the state's 1000 mile coastline. The wells have cost twenty million dol-



lars, and have paid the state eight million in royalties.

California drew these royalties from underwater wells, claiming the ocean oil fields as state domain. Oh no, suddenly said the United States Navy, in the person of its Inspector of Petroleum Reserves. Commander William J. Greenman. How can corporation, municipality, or state claim ownership of the sea and what lies under it beyond low tide? All this is "open territory," belonging neither to state nor corporation, but to any power able to annex it. And only the United States can "annex"-individual states cannot. So the Navy, in-deadly earnest because naval oil reserves on the West Coast are inadequate, for strategic reasons supports the Hobbs Bill, which would declare these submarine oil lands to be the property of the United States

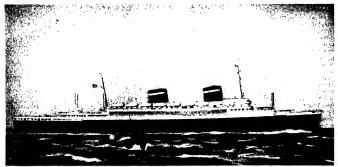


Above are shown three uses for the removable whip-stock—the first to deflect the drill bit past a lost tool, the second to straighten a hole, and the third to hend a bole. At right: Two widely separated wells directed into the same oil stratum



and, therefore, subject to the Navy's ad-

But corporation lawyers and chambers of commerce object bitterly. So does Texas because, alone of the states, it entered the Union not as a territory but as a sovereign nation. The Legislature of Louisiana, a tough state with the richest off-shore oil shelf of all, has already "annexed" as far out as 27 miles. Little Delaware, thinking of sca-water chemicals. has annexed out to 14 miles. Answering California's clargon call, state's righters have gone trooping to Washington with a cohort of harbor-masters in the van. The battle cry they shout is this: "If the Federal Government can preempt oil lands under the sea, by the same token it can possess or abolish the works and jurisdiction of every state or jointly controlled port authority in the union." It is a fantastic and also serious tangle-and also further proof of the profound sig-nificance of John Eastman's discoveries to a world that, for war or peace, cannot live without oil.



To be ready for transutlantic service in the spring of 1940, the America is the most important unit thus far in the United States Government's program for the construction of 500 American merchant ships in the next ten years, or 50 per year

WE BUILD MORE SHIPS

PASSAGE by Congress of the Merchant Marine Act of 1936 and of the amendments thereto, in 1938, evidences the determination of Congress to continue the policy adopted in the Shipping Act of 1916 and in the Merchant Marine Acts of 1920 and 1928 to carry a substantial percentage of our goods in foreign trade in our own ships, and to build up and maintain a merchant marine for both our foreign and domestic trade adequate for our national security and for our economic self-sufficiency

The preamble to the Merchant Marine Act of 1936 varies somewhat from that in the Acts of earlier years by specifying that we should earry a substantial portion of our water-boin eforcign commerce in our own ships whereas the previous Acts mandated that we should earry the greater part. The Act of 1936 provides for a direct subsidy to the steamship operator both in the building and operation of ships as against an indirect system in the Act of 1928.

The new Act requires that the Maritime Commission created under it should make a thorough survey to determine what additions and replacements of vessels are required to carry forward the national policy of the Act, and to study, perfect, and adopt a long-range program for replacements and additions to the American merchant marine; and, in the event that such additions are not provided by private operators, the Commission is different to complete its longThe American Merchant Marine Begins Extensive, Orderly Expansion... Important for Our Economic Self-Sufficiency and National Security

By H. GERRISH SMITH
President, National Council of American Shiphuildera

range program by the construction of vessels for its own account for charter, and ultimate sale if possible, to private interests.

The purpose of the Act is evidently to foster the development of American shipping under private ownership and operation if practicable, but it is quite clear that its purpose in any event is to develop an American merchant marine whicher this can be done through private ownership and operation or not. A reading of the Act abould convince anyone of the many difficulties involved in the development of American slupping under private operation, but the Act has not yet been sufficiently long in operation to determine what the final outcome may

A BRIEF study of our present-day American shipping will show that, with the exception of the few vessels built under the provisions of the Merchant Marine Act of 1928, the vessels in our general passenger- and cargocarrying trade are mostly wartime-built and have, therefore, reached the age of obsolescence It will show further that, in the foreign earrying trade, the United States is faced with the inevitable decision of putting new ships into our foreign trade services or of very soon withdrawing from these services altogether.

It is true that the foreign trade of the United States is far less than it was in the boom years of 1928 and 1929, but its value for 1938 was still appreximate by \$5,000,000,000, and it will undoubtedly continue to be of such volume as to be an important factor in our economic prosperity. Its preservation and development still require a substantial parties pation in its carriage in our own ships.

At the present time, less than 30 percent of our commodities in foreign waterborne trade is carried in vessels under the American flag, while the percentage of the carriage abroad of the American traveling public in our own vessels is about the same.

The Maritime Commission has heeded the mandate in the Act of 1936 to provide for a replacement program so that

new vessels are now off the drawing boards and are under construction in the private shipyards of the United States. Sixty-six scagoing vessels are building, 46 of them for Maritime Commission account and 20 for private owners, In this group are 40 vessels for the carriage of cargo; 13 of the combination type for the carriage of both passengers and cargo; one of the passenger type to supplement the Manhattan and I ashington now in transatlantic service; and 12 high-speed vessels for the carriage of oil All of these vessels are designed to meet the requirements of auxiliaries for national defense. The passenger vessel, to be named the America, is the largest commercial vessel ever constructed in the United States and should be ready for service in 1940

It is gratifying to know that the greater part of those vessels building for Maritime Commission account have already been allocated to existing privately operated, foreign-trans services to take the place of obsolescent vessels

A PROBLEM of great importance which has not yet been definitely solved and may require further amendments to the Act of 1936 in the disposition of old vessels now in service when new vessels take their place in operation. It is important that such vessels, when removed, should not be allowed to enter into competition with either subsidized government lines or other established services. Legislation to cover this matter is now under consideration by Congress,

The present program of the Martume Commission, as frequently stated, is the construction of approximately 50 vessels a year over a period of years to face of necessary replacements. Such a program must have in mind wessels for both the foreign and the domestic trade. The Act of 1936 without some modification, however, does not offer much encuragement for the building of occaning years of the domestic trade.

As a result of the combined national defense program and the program of the Maritime Commission, the shippards of the United States are busy, in fact with a greater volume of construction at the present time than in any previous period of shipbuilding in the United States except during the World War. The 66 vessels now building under the Merchant Marine Act of 1936 involve an expenditure of approximately \$185,-000,000, sufficient to give an average ennual employment to approximately 50,000 American workmen over a period of two years, in which employment the shipyards and the various interests throughout the country that furnish materials and equipment share about

Notwithstanding shippard activity, there is no immediate need of any expansion of shipbuilding facilities other



Looking down on the hull of the America. Divided by 14 watertight bulkheads this ship has been called "the safest ship in the world" by Admiral Emory S. Land

than such expansion as may take place in existing operating shippards.

Much has been said recently, not only in this country but abroad, of the high cost of ships. It is true that the price of ships, like the price of other commodities, has risen materially in recent years, but the reasons are many and are easily seen.

Ship design of today is far different from what it was 20 years ago—or even ten years ago. The development of the art has brought about changes which have added to cost. Added requirements of owners for the greater expedition and safe handling of earge and for the comfort of passengers have added to cost. Government safety requirements have been greatly increased with large additions to cost. The cost of labor is

much higher than a few years ago, and the costs of materials, which reflect the higher labor rates, are also much higher. All of these added costs are almost wholly beyond the control of the shipbuilder.

American shipping in foreign trade is in competition with the shipping of other nations whose costs to build and costs to operate are less than those of American ships, and in domestic trade it is in competition with railroads, trucks, busses, pipe-lines, arplanes, and other means of transportation; and its development is faced with many difficult problems. Yet notwithstanding the problems the problems involved, American shipping is in a new era and its importance to the country is such that I have faith in its continued growth and permanence.

Prehistoric Airfoils

THE development of the hoomerang by Australan aborques marked not of the most brilliant achievements which lluminated the dun arons of paleolithic cavilization. Those primeral foresaw and put into practical service what the advanced intellects of the 20th Century are so laboriously reduceavering; the conception and application of mechanical flight, Pertinent, too, is the fact that they developed their discovery primarily for purposes of warfare, the principles of fight again are being so applied today, threatening modern civilization with annihalation.

Like many scientific discoveries which have proved to be really momentous, that of the boomerang was probably fortutious; perhaps the outcome of idle contemplation of the graceful grations of an acacia leaf or the whirling of the winged fruit of the gum tree. Whatever it was, we must concede the presence of a remarkable mental trast within those savage minds which leapt far beyond contemplation by producing from the wood of those trees a unique and deadly flying weapon.

Even in the incipient stages of tribal life, weapons of defense and offense were a necessity. There would be times when the hated enemy stood beyond the reach of thrust or parry; when the possession of a missile filled the frenzied warrior with delight. He took chances and hurled. It was then that he made his great discoveries. Some implements flew prodigious distances-far beyond the range of a round object of the same weight. Some flew straight; some curled in their flight in curious ways. Why, he did not know; but we must at least assume that he would practice strenuously in times of peace, prizing and reproducing in every detail those implements which behaved in the way he wished.

It is likely that his very crudeness of workmanship was his talisman. Soon he would notice that all implements which were of any use were more rounded on one side than on the other. But this was not the whole secret. The weapon had to be hurled in a special way so that during its flight the more rounded side always came uppermost. This was the key to the prolonged flight. The pressure above the rounded surface was less than that under the flatter surface below. Gravity was, in part at least, compensated. The savage had unwittingly discovered the principle of the cambered airfoil-a principle of aerodynamics to Aboriginal Boomerangs Were Based on Principles Only Recently Rediscovered . . . Analogous to the Helicopter . . . For Sport, Game, Protection

By ARTHUR E. OXLEY, M.A., D.Sc.

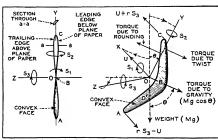


Figure 1 (left) Side elevation of boomerang immediately after throwing. Figure 2 (right): Oblique view about two seconds after projection. See text

be rediscovered untold centuries later Important as this discovery was, many uzzling problems remained to be solved. For example, those weapons which were straight, like spears, would not fly nearly as well as those which were bent near the middle-scimitar-like. In fact, Captain Cook, when he first saw boomerangs at Botany Bay, thought they were crude wooden swords. Unless the implement is bent in this way the subsequent flight is erratic and unstable. A very wide variation in the angle between the arms is permissible; from 90 to 140 degrees. In this recession of the arms we see the stabilizing principle which has been adopted in a variety of successful tailless airplanes; the backward sweep of the wings taking the place of the tailplane.

THE most remarkable feature of effective boomerang throwing lies in the skill of the thrower. The implement is thrown in a horizontal direction with as high a linear velocity as possible. At the instant of release, it is given as high a spin as possible, the implement revolving about its center of gravity O, Figures 1 and 2.

Boomerangs may be conveniently

dwided into two general classes known as the Return Type and the Non-Return Type. The first is commonly used in hunting, for bringing down birds, and so on; the second is used purely as a warwapon. In the return type the arms BA and BC are twisted about two degrees in a right-handed direction. The non-return type has an opposite and usually smaller twist. Upon this difference of twist and the method of projection depend the characteristic flights of the two types.

Whether in the most primitive of implements such twists were intentionally made is not known. More probably they were accidental insertions due to crude workmanship or they may have resulted through warping in the sun's heat. All efforts to find the true origin of the twist have proved abortive and it seems most probable that its influence was derived entirely from observational experience. The fact remains, however, that its presence introduces us to that all-important feature of mechanical flight known as the twisted-airfoil or air-screw. In the linear propulsive and rotary motions of a skilfully hurled boomerang we have all the essentials, except adjustable controls, common to the helicopter-airplane.

When throwing the retorn-type implement, it is grasped by the right hand at A and held over and to the rear of the right shoulder, the plane ABC, Figures 1 and 2, being vertical and the rounded side facing the thrower. At the instant of projection the implement proceeds with velocity U in the horizontal direction OX and rotates with spin Sabout the axis OZ which is also horizontal and at right angles to OX. We are at once confronted with the problem of a wind-mill airfoil projected in an oblique wind. The tip C lias a maximum velocity $U + rS_1$ away from the thrower; the tip A a velocity rS - U toward the thrower. where r = BA or BC. As a result, differ ential pressures are set up by both twist and rounding which cause the principal plane of the implement ABC to rotate about OX The direction of this induced spin depends partly on the twist, which, as Figures 1 and 2 show, acts in a clockwise direction as seen by the thrower, and partly on the rounding which acts in an anti-clockwise direction In all effective, that is, useful, specimens of the return type, the resultant of these spins, S., is clockwise and small, so that the plane of rotation ABC is seen by the thrower to heel slowly over to the right Immediately the plane ABC leaves the vertical, the force of gravity begins to contribute to the clockwise rotation through the torque of the component Mg cos θ acting about the center of oscillation at some point O', Figure 2

IN addition, the spinning boomerang behaves like a free gyroscope and, as such, each of the force- just namedwhich arise from the twist, the rounding. and gravity--causes the plane ABC to precess about the axis OY with a new induced spin. That part due to the twist is negative, that to the rounding positive, and that due to gravity negative. For all effective return-type implements, these component spins are such that their resultant, S, in Figures 1 and 2, is positive and small Thus, as the boomerang flies away, it is seen to heel over slowly to the right and at the same time curl gently around to the left. This combination of induced spins S, and Sa since the rounded side is kept uppermost, results in the implement's "skying" or soaring as it

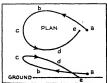


Figure 3: The simple loop flight of a becomerang thrown from point a

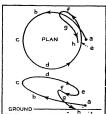


Figure 4 Double loop path of a boomerang when thrown hard

secrets to the left. The evaluation of these angular voluctures explains the tharacter of the simple hosp-flight this rated in Figure 3. The eurling to the left, due to the precession spin S_a is shown in the plan by the are above where a is the throver and c the card of the flight, The searing is shown in the region be of the elevation of the flight path. The axis of mittal spin, S_a is horizontal at a. It clumbs upwards on the thrower's left and at c it is pointing inpart and hackward

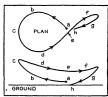


Figure 5 Another double loop, this time in the form of a figure eight

If the implement is to describe a second loop, it must be thrown much harder so that on returning over the thiower's head it has still appreciable linear velocity and spin. What will happen now depends on the position of the uxis of the original spin, S. If this is inclined forward of the thrower, the implement will start to describe a second loop like the first, eigh in Figure 4. If it points backward above the thrower, the implement will proceed to describe a reverse loop behind the thrower, and may, if its energy is sufficient, complete the figure of eight shown in Figure 5. If the energy expires during the flight, the implement will fall gracefully to earth under the influence of gravity.

Still more complicated flight-paths are possible as a result of an expert's skill. There is on record an authentic description of a flight involving five complete loops before the implement glided steeply and gracefully to earth.

In the non-return type, the war-weapon, the twist is in the opposite direction to that in the return type. It is hurled differently. At the instant of projection, the plane of rotation is inclined to the horizontal at an angle θ of from 30 to 60 degrees and the direction of projection is a few degrees "uphill" to the forward horizontal OX There is but a small torque about OX when the implement has reached a horizontal position with its rounded face uppermost. If the implement passes this position, the gravitytorque falls off (since it is proportional to $\cos \theta$) and the torques due to rounding and negative twist bring it back to the horizontal which is its stable position of flight, This very small value of S, necessarily means that the precessional spin S is very small and this is especially true if S. is large, since the precessional spin

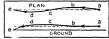


Figure 6 Plan and elevation of

is inversely proportional to the initial spin S, about OY The flight-path of this type of boomerang is shown in Figure 6. At first the implement swerves slightly to the right along ab, and returns to a point on the straight at c Then it swerves slightly toward the left from c to d and returns again at e This sinuous path results from precessional forces which oscillate about the horizontal position of -table flight Since the rounded face of the implement is uppermost, the downward trend of the flight path is countercted and the trajectory appears practically horizontal, as viewed in side elevation, until the forward velocity is almost spent, when the implement falls, -pinning, to earth. Along such a path, the flight of the boomerang simulates closely that of the helicopter-airplane, the horizontal plane of rotation of the arms resulting in a vertical lift which adds to the levitation arising from the camber of the upper rounded surface of the arms.

Near the end of the flight, the steep angle of glide, without the slightest suggestion of stalling, is fascinating to watch. The hoomerang illustrates well those principles of mechanical flight which the modern aeronautical engineer is striving to perfect, safe descent at very steep angles combined with almost negligible landing speed. And yet the possibilities of such heavier-than-air machine-models though we may call them-were known and used in instruments of sport, livelihood, and protection not only among the primeval races of Australia, but among the savage prehistoric tribes of Central India, Ethiopia, and among the Hopis of Arizona.



A MONTHLY DIGEST

Unique Hinged Swing Spans on Bringe

TRIF completion of a reinforced concrete south of Carrels, California, constitute the last link in a series of structures, inseparable elements of Coast Highway Route 56, between Monterey and San Sumeon Its construction introduced immisual problems in heridge design.

At the site of the crossing Big Creek meanders along the bottom of a deep "It" shaped canyon. Foundation exploration in dicated that the steep, sloped canyon wallsconsisted of a badly fractive disale formation and that underlying the stream were Conducted by F. D. Mc H U G H

Contributing Editor

ALEXANDER KLEMIN

In charge, Daniel Guggenheim School
of Aeronautics, New York University

6 inch span with 34-foot 6-inch swing spanwhich vault the caryon walls to the abut ments at highway grade. The structure from abutinent to abutinent has a total over-all length of 587 feet and provides a clear roadway width of 24 feet.

A unique feature of this structure in volves the function of the swing spans which are hinged to the half arches boundation conditions at the bridge cubs indicated that to desure should anti-pate settlement of the end abutments. This condition, should it occur, may be readily overcome by virtue of the lunges which permit jacking the swing spans, back to gradu without detriment to the half are best in effect, any settlement at the abutments is localized and the correction effected with a minimum of expendi

The half arth spans supporting the cold the wing spans are langed at the lower end and held in position by me ans of a sirel expeller the extending from crown to crown of the half arches Unigering of the half arches the seek as the contraction of the half arches the seek as the contraction of the cross-seek which would be induced by chogation and contraction of the eveloar to from temperature change. If F. Ruphal, of Allottan Halfsheaps and Public & Orks.

Lower right: Location of the arch bridge discussed in the text Above One of the arch spans, one of the half arches, and the floating span

beds of clay, sand, and gravel of reasonable bearing value for the bridge foundations. The highway alignment at this location is immediately adjacent to the sea coast and approximately 90 feet above the bed of the stream.

In selecting a structure most suitable for this stee, fundation conditions were of course an important consideration, as was also the locale with its heavy fogs, rains, and saltspray laden winds In fact, the latter consideration ruled against a type of construction suitable for an inland site. Full coinsulction of these factors led to the adoption of the reinforced concrete arch as the inost suitable type for this location.

The arch structure comprises two main arch spans 177 feet 6 inches long across the canyon, and two tied half arches of 81-foot

TEN-MAN PNEUMATIC

RECENTLY under test at Wright Field, Dayton, Ohio, has been a pneumatic life raft, developed for use with large air planes of the hombardment type when engaged in overwater flight. When inflared and placed in the water, the raft is capabile of seating 10 men, while a life line attached to the raft and extending around it will support 10 additional persons.







The pneumatic life raft ready for inflation and, right, the raft in use

The supporting structure of this raft con sists of a latex rubber bladder with a heavy rubberized duck outer cover The bottom is ol heavy rubberized duck fabric and con tains three pneumatic inflatable seats. The latex tubes are equipped with valves and manifolds for CO₂ inflation About five tion operation. The cylinders containing the CO, are attached to the raft and fed directly into the tubes. The weight of the raft when inflated is approximately 115 pounds. When folded the raft can be rolled into a bundle approximating three cubic feet of space

Four two-section metal oars make propel ling of the raft possible in the water for a considerable distance Four army canteens of water, a quantity of emergency rations, emergency signal kit with six red flares, and a syrotechnic pistol form additional equipment All of these are eneased in water proof holders

In order to repair possible panetures while afloat, an emergency pump is provided With a repair kit, this makes it possible to keep the raft affoat indefinitely When inflated, the buoyancy is such that the raft is virtually nonsinkable. It will float even if turned upside down on the water, and has been found to be considerably more stable and more easily handled than the smaller sizes

In the hombardment airplane, the rafts will be stowed in a position within easy reach of personnel Experimental testing at Wright Field having been completed, an order was placed for

a service test quantity. CATALYTIC REFINING

* ATALVOTTO ---- ! !----A routine method for the manufacture of petroleum products. Limited originally to large plants, because of the heavy investment required, catalytic refining processes now have been developed for the smaller plant. Increased production of gasoline of 2 to 8 percent is reported by the operators of the "midget" catalytic plants, together with an increase of 2 to 4 percent in octane rating of the gasoline. Similar results, with even greater increases in gasoline yield and octane rating have been reported by operators of the larger catalytic plants.

As currently operated, catalytic refining plants produce about 45 percent of 80 octangasoline the first time the crude oil is passed through the stills, making no fuel oil unless desired, and producing only gasoline, gas, gas oil, and a small amount of heavier residue. On subsequent runs through the stills, additional amounts of gasoline and other usable products are obtained. Conversion of 100 percent of the crude oil into gasoline is

physically possible under the new to huque Catalytic refining adds the action of a eatalyst to the action of heat and pressure, the physical contact of the oil with the catalyst causing a chemical reaction which converts greater portions of the oil into gasoline Refinery gases, resulting from cracking and distillation, also are subjected to catalvise processing, adding still further yields

of gasoline Catalysts orchnarily used have metallic compounds or alloys as their base. A typical catalyst is a mixture of silica and alumina. pressed into bricks Other catalysts are made of acid treated clay, containing oxides of manganese and nickel The effectiveness of the catalyst decreases very little in use and can be renewed after continued operation

A BLIGHT-RESISTANT

CHESTNUT

SEVERAL years ago the Bureau of Plant Introduction of the U.S. Department of Agriculture brought in shipments of the Chinese chestnut Castania mollissima in an effort to find a variety that would be resistant to the chestnut blight which worked such havor in the chestnut area of the United States that practically every American chestnut has been destroyed Crosses of one or more of these chestnuts were sent to the Bartlett Tree Research Laboratories, and among them was one which has grown



Blight resistant

for 20 years and has fruited for several years The nut, too, is similar to that of the American chestnut in size, quality, and sweetness Mr. Bartlett carly recognized its merits and has distributed more than a thousand oneyear-old seedlings to commercial nut growers in different sections of the United States. Because of the service rendered by Mr Bartlett in co-operating with federal agencies in the distribution of this promising cross. the chestnut has been named by government

workers the Bartlett chestnut. In some instances, our native chestnuts have sprouted for a few years, and some have even frosted but then succumbed to the blight so that it does not appear likely that a disease-resistant native chestnut will grow again in the areas originally affected by the blight -C. F Greenes arpenter

INSTRUMENT FOR

CHEMICAL ANALYSIS

BASED on established principles and de-veloped by the engineers of the Fisher Scientific Company, a new instrument has been announced for conducting qualitative and quantitative analyses in both organic and morganic industry.

The Electropode, as the compact instrument is called, employs the dropping mercury electrode system for analysis. With this ystem, a series of potentials are applied to drops of mercury as they fall through the solution being analyzed. The results are solution being analyzed plotted and the presence of each particular ion is indicated by an increase in the current at a specific voltage. The extent of the increase depends upon the ion concentration.

Another View of GERMAN AVIATION

WE have heard glowing reports of German aviation from many sources, and German bombers have been Hitler's trump card in his diplomatic or, rather, undiplomatic maneuvers. Is it just possible that the Reich's strength in the air is over-rated? Picture Post, a well informed English maga-zine, published some interesting views in this regard.

One hundred pilots a month were killed last year in the German Air Force, which is an indication of hurried training, and of weakness rather than strength.

Visitors have apparently free access to German airplane factories and are duly impressed with such facts as the production of three-engined bombers at the rate of nine a day, or single-seater fighters at the rate



Exterior of the pressure tunnel for testing airfoils and airplane models

of twelve a day But such glimpnes may be dichberately milaculard, Petture Post says. "That factory may have been building its sirplane parts for months, and other parts may have been worked on by other factories, and all might have been ready for the final assembly of aircraft the day before the visitor was slown over." The final rapid assembly might thus well be the culmination of months of relatively slow effort.

Again, in building American Paut & Whiney engines under license, the quality of the steel was so had that the crankchaft of the engine had to be strengthened, weight of the engine had to be strengthened, weight of the engine increased, and over-all efficiency lowered. It is also reported that the German-built Pratt & Whiney Waspa have to be overhauled every 35 hours, whereas in the United States overhaud is placed with the control of the time that American true will serve.

These are rumors Still, there is some reason to believe that reliability may have been sacrificed to quantity in the Nazi Air Forces, and in time of war, only that airplane counts which is capable of continued service.—4. K

MULTIPLE HANGARS

FROM time to time we have pointed out in these columns that hanger space is valuable and that hangar rent is an important item in the budget of the private plane owner. Considering the present type of conventional hangar, elaborately constructed in steel and concrete, with high roof trusses, it is obvious that hangars cost money, and that the present high rents are probably a necessity. To overcome this drawback, the Edwards Multiple Hangar has been designed to reduce the cost of airplane housing, and also to provide the owner of an "airplane garage" with housing of such flexibility that he can adjust his space to current requirements and not be tempted to speculate by erecting an expensive building which may remain half empty.

One of our illustrations shows a sevenunt hanger block. The low overall height, made possible by use of a special cantilever roof truss, is only 16 feet as compared with the 36-foot height of the egoventional hig hangars. Thus reduces the minimum area required for the landing field, since the approaches become lower. The staggering and overlapping of the hangars reduce the ground required for a number of machines to the absolute minimum. Each unit houses a single plane. The hangars can be built singly, or in blocks of two or more as desired. The privacy of each block should make an appeal to the smaller flier — A K

A HUGE PRESSURE TUNNEL

OF great interest to visions at Langle-Field as the 10-feet pressure tunnel shown in one of our photographs. To science conditions comparable with those of flight, the new 19-feet tunnel is designed to use are at a pressure of two atmospheres, the apeed of the 19-feet diameter pet will be 250 miles an hour in operating the tunnel, the operators will work inside the pressure chamber, tike the "sand hours" who drive tunnels under our rivers. Special aur locks and a decompression chamber will be provided.

The tunnel is of atecl tubular construction, with a maximum diameter of 60 feet, a length of 270 feet, and a world to 128 feet. The 34% foot propler will be driven by an 8000-horsepower electric motor. In the working chamber the large forces on arrifol or air-plane model will be recorded by automatic halances, which will give the engineers a faithful picture of what they may expect from the actual flying machine—A. K

"SMOKED" GLASSES

THE American public has declared a defleasive war on invisible rays, using for armor certain types of glass which protect the eyes by admitting visible light and stopping the invisible ultra-violet and infra-red rays. A 700 percent increase in the use of this glass since 1928, amounting to many tons, is reported by the American Optical Company.

According to latest scientific investiga-

tion, the invisible ultra-violet and infra-red rays are not necessary for seeing and in excess quantities may produce pathologic eyconditions. The protective glasses, the composition of which is responsible for their absorptive qualities, are used for outdoor wear to protect the eyes from excess light (glare of the sum) and the invisible rays.

Many years of research were required to develop efficient absorption glasses, Dr. E. D. Tillyer, the optical company's research director, stated The problem was complicated from the beginning by the difficulty of cutting out the invisible rays and maintaining at the same time a desirable transmission of the visible light rays.

Finally, after long experimentation, certain elements in pure form having ultra-violet and infrared absorptive properties were discovered. Added to hatches of glass, these clements produced glasses which transmitted light without undearable color distortion and at the same time uniformly absorbed the invisible rays.

The elements having these remarkable properties, Dr. Tillyer stated, were cerium (a rare metal resembling iron but much softer) and very carefully balanced quantities of iron compounds. To prevent color values from being distorted, he emphasized, the ratio of the iron compounds must be watched very carefully

CONQUERING THE ATLANTIC

IT is now a matter of record that Pan American Airways have crowned their many achievements by the first scheduled flights across the Atlantic, under commer-Pan American and to the Boeing Clipper (See also page 76, this issue.) The achieve-ment is all the more remarkable when we consider how brief is the chronology of transatlantic service. Scarcely twelve years ago (October 1927) the first international airmail and passenger service extending beyoud the horders of the United States was established by Aeromarine on a little 90mile airline between Key West, Florida, and Havana, Cuba. Early in 1929 Pan American Airways formulated its first plans for transatlantic operation, undertook a complete aurvey, and adopted specifications for aircraft, weather and radio services, base facilities, and so on. In 1931, the first "laboratory were made on a northern great circl route. In 1932 and 1933 there were expeditions to Greenland, and the building of the Sikorsky S-40, the first four-engined flying boat. The year 1933 saw another survey head ed by Colonel Charles A. Lindbergh. In 1935 was held the first international conference on Atlantic air travel. Then came more surveys, a larger Sikorsky, and finally, in 1938, the Yankee Clipper was constructed. Then came shake-down flights, more surveys, and, finally,



Multiple hangers for airplanes conserve space

in May 1939, the first regularly scheduled flight. To the public the establishment of progress has been very rapid, when one considers the immensity of the task.

Pan American will not be left alone in the transatlantic field. We may expect Air-France, Imperial Airways, Lufthansa all to be active. And, moreover, there will he an other American company in the field. Thus-American Export Airlines has filed with the Civil Aeronautics Authority application for a certificate of convenience and necessity covering Atlantic routes from New York or Baltimore, via Botwood, Newfoundland, to Foynes, Ireland, Horta, Azores, Biscarrosse and Marseilles, France, As soon as the latest Consolidated flying boat, shown in one of our photographs, has been approved by the Authority, three survey flights will be made. one of these being non-top from New York to Biscarrosse A strong argument in the application is the fact that the new airline will be affiliated with American Export lines, which maintains a fleet of 18 surface vessels. From five to eight of such ships are normally at sea at all times between New York and Gibralian With complete two way radio and meteorological observation services. the help to navigators will be immense. In vestment hankers have bought enough stock to finance the venture on a sound hast-

The Consolidated Model 31 Flying Boat has made successful test flights with 52 passengers and a crew of five. The Model 31 is a twin-engined flying boat, powered with Duplex-Cyclones of 2000 horsepower each The gross weight is approximately 50,000 pounds Hydraulically operated Fowler flaps extend from the hull to the ailcrons The rear portion of the hull is so designed that the tail surfaces rise high above the water, and the vertical surfaces project well below the stabilizer, which is a safeguard against spin. There will be two full decks Wing -pan is 110 feet (arrying 28 passengers, the boat will be capable of non-stop commercial service across the Atlantic.

Pan American with Boeing Clippers, against American Export with Consolidated Madel 31, will provide the competitive zest which is needed to secure maximum effort and efficiency on the part of both companies. -A. K

No-SLIP PAINT

FROM United Laboratories comes announcement of a new non-skid paint for use on stair treads, concrete floors, steel floor plates, and other places where resistance to abrasive action is desired. It is known as Armor Plate 419, made up of stainless steel flakes in varnish vehicle - Streamlining.

MOST POWERFUL AIR-COOLED ENGINE

BUILT by Wright Aeronamical Corpora-tion, and known as the Duplex-Cyclone, the most powerful air-cooled engine in the world is of the radial type with 18 cylinders arranged in two rows of nine each, and is rated at 2000 horsepower. It derives from the Double-Row Cyclone of 14 cylinders which is rated at only 1500 horsepower. Provided always that a suitable propeller can be designed to absorb its immense power ef-ficiently, this latest engine will do a great eal to increase the speed both of our trans-



backs reported, however, that the effect is

ports and of our large Army bombers I wo of the Duplex-Cyclones have already served soon lost. Making inquiries on other phases of the in a large flying boat of Consolidated Air problem, the investigators find that praccraft which has been recently test flown on the Pacific Coast with marked success and tically every rubber part requires some de-

is described above. A A. LAAK WALTONS USE METAL

MONEL braided and twisted fishing lines are becoming exceedingly popular, and in England the foremost reel manufacturer uses Monel for spindles, disks, "agate" rings. and ferrules on rods. Here, at home, Monel is used for a weedless fish lure, red on one side, a bright tumbled finish on the other And when Wisconsin fishermen began to ruise a row about galvanized minnow buckets rusting rapidly, they changed to Monel

NEED FOR RUBBER

LUBRICANT

S the result of an extensive field survey. A the Acheson Colloids Corporation conservatively estimates that 200,000 greaserack attendents consider squeaking rubber parts a pet peeve in automobile lubrication In desperation these individuals apply brake fluid to the offending points. One concludes from the frequency and number of come-

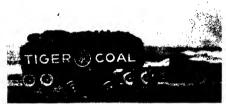


gree of Inbrication. Spring shackles, sway

climinator bars, steering columns, shock absorber arms, spring pads, fan helts, mount-

Below. Engineers inspecting one of the Duplex-Cyclones, world's most powerful air-cooled engines. Above: Rear of Duplex-Cyclone. showing the various accessories





World's largest truck, compared with an ordinary truck in foreground

ings, silencer strips, and bushings—to name the more important—are included in their

In addition, this survey points to a growing popularity of callidad graphical preparations for the purpose. Because of its chemical next period of the purpose of the purpose of the purpose and soften or otherwise deteriorate rubber, but rather trucks to prevent a when combined with glycerine according to U. S. Parent 2.083, 176 Berng widely known as a positive dry lubricant, colludad graphite also provides squack-free lubrication for the removest and cluster of fitting parts. Evidence now available suggests that automobile mandata turers and owners will presently use graphited trubber lubes a sandard lubricaning practically approach of the providence o

WORLD'S LARGEST TRUCK ELECTRICALLY DRIVEN

ELECTRICITY drives the guart trook, shown in our photograph, which hashs a 70-ton pay load of coal from strip pit to the tipple, over a four mule pravise roadway of the Sinchar Coal Mining Company's Tiger mee in Hume, Mosouri. Two General Electric generators, each direct-connected to a button-briming Heresiles engine under the hoad of the trick, furnish energy for traction motors connected to the two reare-out

The trailer is 35 feet long, 12 feet wide, and 10 feet high, Total weight of load anil equipment is 103 tons.

ARTIFICIAL HEART

REMARKABLE artificial heart which can replace any animal heart for pumpme blood at its ordinary temperature of 98 degrees. Fahrenheit, through the arteries and veins has recently been perfected by Dr. Gerhard Katz, of Tulane University, This heart can, in fact, be used either for the perfusion of living organs with fluids other than blood, or for the maintenance of the circulation of an experimental animal. It can be operated at a maximum speed of 100 strokes a minute, although a lower rate is usually preferable. An air valve in the heart is opened and closed by a photo-electric cell activated by two beams from two light sonrees, which pass through the glass tube and are interrupted by the blood column. These light beams are focused by leuses in such manner that one passes through the bottom of the tube, while the other one is focused on it at any desired height

During the systole operation, the an valvis opened and the top light is dark. Air pressure then pumps the blood out of the tube into an experimental artery, for example, until the blood column reaches the beam of the bottom hight. This heam is thus al-



Above: The artificial heart perfected by Dr. Katz. Below: A closeup view of the mechanism used for research on experimental animals

lowed to penetrate the glass tube and activates the photo cell, which then closes the arrivalve and switches on the top light. The output of blood per stroke is regulated by the height at which the top light-beam passes through the glass tube. Increase or decrease in the venous blood return to the heart correspondingly clunings the ordinary rate of

This artificial lieari his been used in studying the action of arteries, velos, and kidneys, when dearbed from the animal to wheth they originally be longed. An outstanding advantage is that it can be slowed down or specific up as desired, its operation is wholly not basical It contains neither timmotion for the state of the state of the contains the state of the state of the state of the tribber. And there are no priories, because the blood which comes in contact with them sometimes becomes tow. It is the first apparative of its kind operated by use of a plin track time till.

This heart is not designed to serve as a substitute for a human heart in the prolongation of life, neather is it available for the allevation or cure of heart ailments. Arouse dugs for the treatment of heart trouble are now used practically by physicians and specialises. Artificial hearts for experimentation and research are not news, they have been used by experimentates during the list 55 years on the study of blood vissels, vitus, arteries, and their reactions.

NEW SMALLPOX VACCINE

On the heels of news of recent smallpox outbreaks in New York and Tennesse conies an aunouncement to scientists of a new smallpox vaccine which eluminates the severe scars and other inconvenient features of ordinary vaccination.

The new vaccine was developed by Drs Thomas M Rivers and R D Bard and S M W and of the Hospital of the Rockefeller In stitute for Medical Risearth in New York It is made by growing vaccine virus on a special medium consisting of minered chickembryo tisses and Tyrode's solution. Vaccinations against smallpox ordinarily are made with call (Jupit) vaccine virus.

Vaccination with the new vaccine virus should be followed, within six months to one



year, by re-vaccination with calf lymph virus. the Rockefeller scientists advise in their report to the Journal of Experimental Mediindividuals will not become sick and will not be subjected to the dangers associated with primary vaccination with calf lymph virus, but will obtain a solid and lasting imminuty to smallpox

No sear forms after the primary vaccina tion with the new vaccore virus, it is reported, if the moculation is properly made Nor is there any fever or discomfort. Following revaccination later with calf lymph virus, very few of the children had fever or other symptoms, and what sears occurred were only 'small superficial' ones. Science

ANTI-CORROSION

AN aqueous solution of alcohol is A one of the commonest auti-freeze solutions for automobiles The addition of less than I percent by weight of natrate solts, according to a recent patent, will prevent conresion of aluminum parts of cooling Systems

IT "TALKS BACK" TO YOU

THE machine shown in one of our illustrations can both "listen and "talk back ' And it a perfect mimic too In fact that's its job It "mirrors, what is said to it -sends it back as accurately as a mirror reflects your image

Looking like little more than an endless belt of narrow steel tapes wound upon small drums, this device is a voice-recording and reproducing machine that has many uses One of the first of its kind was introduced several years ago as the "voice morror," and thousands of visitors to "open houses" con thousands of visitors to "open houses ducted by the telephone company in New York State and elsewhere used it to "hiai themselves" One spoke a message into a telephone transmitter, and then heard the exact words and tones snoken back to hun through the receiver

Applied to everyday use such devices tire



Spray painting over a floor grating; no booth is necessary

vide the "voice" for the telephone company a weather forecast bureau in New York City. and in New Jersey are used to give farmers and produce dealers crop reports by tele-

In recording the voice, a moving belt of steel tape passes across the poles of an electro-magnet at a rate of about a foot a second while speech currents produce a varying magnetism on the tape. The machine will repeat the message indefinitely. The recording can be "erased" by the flick of a key, and the machine is then ready to take a new message

SPRAY PAINTING WITHOUT BOOTHS

I INIQUE facilities for spray painting which climinate painting booths re move the fire hazard, and make it practical ly impossible for operators to inhale the -pray, have just been installed in the lathe manufacturing plant of the Monarch Ma

cline Tool Company. I athes are now being painted on the assembly floor within a few feet of other operations with no walls or partitions of any kind to screen off the sprayers. Painting is done over a seven, by twelve foot grating in the

floor through which air is exhausted at the rate of 200 feet per minute. The fume-laden air is disclarged into a large welded tank located directly below the grating where a water effectively segregates the solids in the paint fumes. This precipitates a sponge rule ber-like substance which can easily and convemently be cleaned from the pit. The air is then carried off through an underground tunnel to an outside exhaust stack

Since the solids precipitated in the water are non-inflammable, the fire hazard created by the highly combistible pyroxylin which collects around the consentional spray booth, on the floor and in the exhaust system, is aliminated.

With the an suction down instead of up. and since the painter never has to hold the spray gun above his head, which would put him between the spray gun and the exhaust the operator is never in a position where he can inhale the fumes. The draft is strong enough to pull effectively into the exhaust any spray not immediately deposited on the social being painted.

FOR POLISHED PARTS

APPLIED by brush or spray gun, No-Rust Liquid V-15, recently introduced by Frost Paint & Oil Corporation, dries quickly to form a tough, non-porous film which resists abrasion, the elements, and salt water, and is recommended as protection for polished steel parts in storage or slupment. It is readily removed by wiping with kerosene or gasdine -Streamlining

VITAMIN ALPHABET

COING OUT OF STYLE

THE vitamin alphabet, that is, designation of the various vitamins by letter, is going out of style For example, if you want to be really up-to-date, you must learn to say ascorbic acid instead of vitamin C when you are referring to the substance in orange jaice for other citrus fruits, tomatoes, and other vegetables) which prevents and cures

This may be discouraging, especially if you pride yourself on having really learned the vitamin alphabet, or most of it. But the scientists who have most to say about vita-



teel tapes and recording and reproducing mechanism of the "back-talker"



mins. the nutritionists and hinchemists -- are trying their best to get the vitamins out of the alphabet They make the point that the letters did very well for names in the early days of vitamin discoveries when only a few were known and not much was known about them. Now, however, since there are about as many vitamins as letters of the alphabet. with half-a-dozen going under the name of B, it is confusing and even leads to maccuracy to call these essential food factors by letter.

Some of the vitamins have been identified cliemically and even made synthetically They have regular names, just as other chemicals have. Vitamin C is ascorbic acid Thiamin is the beriheri preventing and curing substance that once went under the name of vitainin B or B. Nicotinic acid, the stuff that is curing pellagra, is the chemical that was variously called vitamin B2, vita-min G and the P-P or pellagra preventing factor Riboflavin is another diet-essential G Recent discoveries have shown that it is necessary for the health of both man and other animals

The anti-sterility vitamin, formerly called E, 18 now known as alpha tocopherol Vitamins A and D may keep their letter names for some time, because there is not so much confusion about them as about the B vitamins Until the chemical composition of other vitamins is discovered, however, scientists favor calling them by descriptive names, not by letters .- Science Service

NEW AUTO SPRING RELIES ON RUBBER

DEVELOPMENT of a new type of automobile spring which uses three pounds of rubber and seven pounds of steel in place of the usual all-steel construction was announced recently by the B. F. Goodrich Company The new spring requires no lubrication and reduces rattles and squeaks reports Science Service.

Rubber springs have been invented and patented many times, but none has ever come into general use. The new spring gets around the difficulties of most of its predecessors

Above: Rubber springs in the front-end of a motor car. Below: One of the springs, showing how rubber is placed between a shaft and a shell and stressed in torsion



through the fact that the rubber is under compression and twisting or torsion pressure metead of being under stretch or tension When under tension, cracks develop in the surface of rubber and it soon deteriorates

The rubber surrounds a central steel shaft and is in turn surrounded by a pair of hemispherical steel shells. By making the rubber layer a little larger in diameter than the meide diameter of the steel shells before they are fastened together, the rubber is put under pressure. High pressures are applied during the curing process to bond the rubber and metal firmly. The spring is stressed in torsion by anchoring either shell or shaft to chassis and rotating the other member.

The entire arrangement takes advantage of one of rubber's most marked and most de strable characteristics, its ability to absorb and damp vibration. This has not previously been done in the springs in widest use in automohiles.

NEW PLYWOOD FINISHES

TO extend the usefulness of plywood further in modern building construction. 1 F Laucks, Inc., has presented two important new paints that offer not only decoration but fire resistance as well to plywood construction.

These two new paints are known by their trade-names, Rezitex for certified exterior plywood, and Plasterez for interior plywood walls. They have as their binder a apecial combination of synthetic resins, which as-sures perfect adhesion to the plywood, and a surface that is durable and non-brittle. Both paints are heavy bodied and will cover up small cracks and joints in the plywood

These products were originally developed for application on plywood, but since have proved themselves suitable for application on all types of surfaces-plaster, wood, metal, and wallboard. Rezitex and Plasterez both simulate plaster, stucco, or concrete finish

HOOVER DAM

N newspapers recently there has been considerable comment regarding the question of the name of the dans recently completed in the Black Canyon of the Colorado River Officially named "Hoover Dam" some yearago, its designation was changed to "Boulder Dam" about the year 1933 It now appearthat this change was never officially made for in an exchange of official correspondence recently, the United States Attorney General indicated that the name "Hoover Dam" had been legally fixed and that it was not feasible to change it Since new maps will carry the original designation. Scientific American will henceforth refer to this projest as Hoover Dam

BACTERIA AND MINE FIRES

MINE fire is sometimes extinguished A VINE tire is sometimes calling the area by blocking off and scaling the area To determine whether or not the fire is out, usts for carbon monoxide are made of the -caled atmosphere

Recent studies by the U S Bureau of Vines have shown that, under favorable conditions, unidentified bacteria or micro-organisms which inhahit waters and slindges of anthracite mines react with carbon monoxide and produce carbon dioxide. These studies show that failure to find CO in a scaled area does not prove the absence of fire as hadteris may consume the gas as fast as it is produced by the fire

PROGRESS NOTE ---TRAFFIC CHANGES. 1904 to 1937

BRITISH automobile traffic appears to be moving backwards

A survey of traffic speeds by Great Britam's minister of health reveals that in 1904, the average speed of a horse-drawn bus travcling from Swiss Cottage to Oxford Circus, in the heart of London, a distance of about four miles, was not quite nine miles an hour. In 1937, several tests indicated an average speed for the same journey by motorbus of about eight and a half miles an hour.

In 1904, the average speed on a trip from Highbury to Piccadilly, about five miles, was a little more than eight miles an hour. Today, the speed is somewhat under eight miles an hour .- Science Service.

LONDON PLANE TREES

TONDON plane trees, among the few species that can stand the smoky air and other unfavorable conditions of city life, are now menaced by a killing epidemic are now menaced by a kning epitemic disease, the U. S. Department of Agriculture recently reported. Seven thousand of the trees are dead in the Philadelphia region, and 700 in Baltimore. The disease has also appeared in Washington.

The infestation is a slow killer. In the

first year, cankers appear in the bark of the trunk and large limbs and dark streaks in the young wood. In the second year the leaves thin out. The tree may die then, or linger one or more years longer.

The London plane is a cross between the American and European plane tree or sycamores. It is widely used as a shade tree along streets and in downtown parks because of its hardiness under cuty conditions. Its disappearance would denude many American cuty streets and leave cuty fore-ters and park commissioners at a loss to find an equally good subbitute.

good substitute. Department of Agriculture plant pathologist, is seeking information regarding the distribution of sok London plane trees. It is requested that chips of young wood from planes or sycamores suspected of having the disease be sent to the Division of Forest Pathology, U. S Department of Agriculture—Science Service.

WATERPROOF FABRIC

ZELAN is a recently announced waterrepellent finish for fabrics Developed by duPont, it is claimed that the new finish is the first which will still shed water after the merchandise has been washed or dry cleaned many times.

Other water-repellent finishes coat fibers like wax on a thread, and some of the waterproofing chemicals cover the entire cloth and close the pores of the material, making the garment hot and uncomfortable to wear

Instead of coating the fibers, it is said that 7elan goes into each individual fiber. It be comes part of the material itself without closing or clogging the pores, thus the cloth can "hreathe" and the garments are much more comfortable to wear.

AN UNFORESEEN RESULT OF AIR CONDITIONING

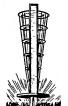
Whien an air-conditioning unit was installed in one of Boston's large pewleys stores the primary consideration was the comfort of customers and clerks. It was soon owdent that there was a more practical benefit from the installation. The himidity contion and the removal of sulfur from the air by the air-washer climinated a source of silter tarnish, and it was found that ailver articles on display had to be polished much less frequently.

THE CULTURE OF ORGANS

AT the instant of a human bring's legal Ad the hand of hours and one times even days thereafter, major sections of the body are still aliev. Consequences and many brain cells may be deed, yet at the same time the beart tissues as well as many another tissue may often be found living, merely in a low state of activity. Delt technique frequently can induce an apparently lifebase beart to throb. These facts have long been established, but little has been made of them until recently.

Now new methods yield important discoveries. The hearts of dead patients can be revived and kept beating for hours, within the body or cut out. In such revival, blood or a bloodlike symplete faul is supplied to the heart and its vessels through a double set of tubes. From one reservoir, fauld at high pressure is forced through tubes pieceing the

A FAIR WITHIN A FAIR



by Westinghouse

It has taken a World's Fair to make us realize all over again that ours is not a commonplace business. More than 12 months ago we undertook the task of erecting our own building at the New York World's Fair. Today there has sprung up a treasure house of wonders devised by the inventive minds of an organization trained to think in terms of practical applications rather than spectacular showmanship.

Instead of an ordinary cornerstone laying, we buried the Time Capsule with its significant message of our times for people who will live 5000 years from now.

In our laboratory we discovered that everyday experimental equipment could be transformed into headline attractions for a Playground of Science where visitors crowd the aisles to see the shape of their own voices, transmit music over a beam of light, and demonstrate to themselves other mysteries of science.

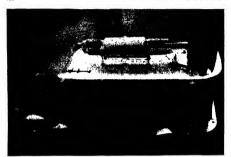
An engineer's dream was brought to fulfillment in the form of a friendly Frankenstein who walks and talks, counts on his fingers and distinguishes colors to the delight and amazement of crowds who throng his every appearance.

Our auditorium cannot accommodate the audiences who stand in line to witness the triumph of modern woman over drudgery, as accomplished by one of our lesser-known appliances.

To add to the enchantment of the Fair as a whole, as well as our own building, Westinghouse engineers took advantage of the latest developments in illumination, hydraulics and control devices to create the Singing Tower of Light with its breath-taking symphony of music, water and light.

Behind the scenes, Westinghouse has collaborated with the Fair and other exhibitors in making possible all the wonders of this World of Tomorrow. We furnished the lighting and power equipment for the spectacular Lagoon of Nations where thousands of fair-goers stand nightly in awed wonder. The longest electric stairway in the country, the exterior lighting of the Perisphere, the production of Florida climate on Long Island, are examples of a few of our transportation, lighting and air conditioning contributions to this greatest of all fairs.

It is gratifying to realize that our own people were able to take a World's Fair in their stride and handle it as they would any ordinary, everyday job. We hope you will visit our building and spend time enough with us to catch the spirit of Westinghouse which we have tried to interpret to you in our exhibits.



aorts and passing directly into the heart's private circulatory system, the coronary vessels. Frum a second reservoir which developes a lower pressure, fluid is made to flow less forcefully through another tube, that goes forcefully through another tube, that goes and the property of the sorts and the past the valves of the sorts and not her vestricle. By this method, hearts can be perfused as four hours. These are human hearts—
which had stopped all action at death. Hearts of experimental animals can be kept alive much loaser.

and noger moder to a considerable and the advent of methods which should gave the definite life to organs in glassware. They should not seen to organ should not seen to see the seen of t

WALL PAPER REMOVAL

A PRODUCT developed for use by paper hangers and decorators, Aerosol KA, decreases the tendency of water to form droplets by lowering the surface tension Thus, when one ounce of the powder is added to one gallon of water, the solution will wet old wall paper almost instantly and permit its removal more readily

SOUNDPROOF PORTABLE DIESEL GENERATING PLANT

PYERROWS went up early this apring when Paul Grosse drow his larest creation, an ultra-modern soundproof, portable, Deered electric generating plant onto the Schmick International Studio lot in Holly-wood, Grosse's striking looking "Fran child" was built from a re-vamped cab-over-engine truck chasses entirely of Durla and at a cost of \$24,000. Entirely portable, the new sound-proof generating plant makes it possible to get within 200 feet of a movie set on location without discussing the sensitive sound microphones. An ordinary generating set must be at least 1000 feet away with a need

Above: The soundproof truck, with muffler and oil radiator on the roof. Below: The truck driver's seat can be reversed so that the operator faces the convenient controls of the Diesel-powered generator



for less than one fourth the cable, transmission line losses of the high amperage direct current are greatly reduced. Grosso says he can work as close to a set as 100 feet with a building or some sort of a deflector between the generator and the micropliones.

Grosso has found a way of halancing the speed of his Diesel with the amperage loads. something electrical engineers have been trying to do for years. Any variation in the engine's speed, large or small, does not affect the voltage output which has been predetermined and set by the master control knoh This is of tremendous importance to the movie industry, especially now that Technicolor is gaining in popularity. It is well known that color movies demand a great deal more light than black and white movies Any variation in the line voltages tends to change the intensity of the artificial light which, in turn, causes the hue of the photographed color to change. As the light decreases, many colors fail to register and all tend more toward the blues.

Total thickness of the walls enclosing the plant is three inches, made in three separate "layers," with a one-inch, sound deadening, are space between each. On solid neither where sound-proofing was devired, a mixture of cork and tuther was built up with a "purp again to the proof proofing the proofing of the

SULFANILAMIDE TREATMENT OF EAR AILMENT

THE new drug, sulfandamide, has extended its sphere of usefulness to cover onte media, that extremely punful disease of the middle car that often is the forerunner of a masterial operation.

Eighty-eight patients with out is media due to heta hemolytic streptococcus were given sulfanilamide in a recent series of cases and only seven required a mastoid operation, reports Dr. Gibert E. Fisher of Baltimore in the Journal of the American Medical Asso-

In a control group of 95 patients who were given the regular treatment of puncturing the membrane for drainage and irrigation, 66 re quired a mastoid operation

Moreover, the patients treated with sulfanilamide recovered in one third the time taken by the other group—Science Service

DRY ICE AIDS WELDING OPERATION

In the construction of a 40 foot welded steel boat hull, an unisual expedient was used to prevent the high temperature from buckling the steel plates. Four cakes of dry tee were used, two made and two outside the hull. The cakes were placed as close as possible to the weld while the plates were being joined, and it is reported that the resulting flat surfaces are fully satisfactory subjusting flat surfaces are fully satisfactory.

COLORING CONCRETE

FLOORS

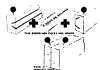
LACK of permanene and lack of revitance to measure and alkali are two bages that make two bages that make a part of the locating of converte floors after they are laid. When a panti-ype voloring is used there is superimposed a relatively soft oil fina on top of hard concrete, and this does not withstand hard triff. Also, the slikel in the concrete, in combination with moisture reacting with the acid of the vegetable oils, cause sponification, or breaking down of the paint film. Robber resum overcome this handleap to floor have been confined to the addition of a mineral color to the too.

A new system, called the Truscon Flor-Dye System, developed by the Truscon Laboratories, may be used on old and well-matured floors. The only limiting condition is that the floors must be dry at the time of application. This is called a "system" because it consists of two materials: (1) Flor-Dye, a "penetrant which stains, seals the porce, and helps hind the particles at the surface; and (2) Flor-Dye Dressing, which protects the Flor-Dye and affords a polish or sheen to the surface. In some cases, Flor-Dye may penetrate a mere \mathcal{H}_2 of an inch and in others it may penetrate as much as $^{1}_2$ inch. Because it does penetrate the concrete, the concrete still takes the way

Both materials come in four standard colors—the red, Spanish green, Julia brown, and marcon—and both materials should be used as a complete system on any floor color ang job. The system is not affected by most over a falkal in the conert to It as acid-pinosi, oil pixoli, non-staining, but not gasoline proof It cannot be applied over paint, satisfies the proof the cannot be applied over paint, satisfies, the completely removed.

SIMPLE JOINT LOCK

WHEREVER any two solul materials are joined, a new device will find auplication and in many cases will do a better job of joining. This new ilevice is the Homer Spline Lock, which those who have myesti gated it believe will find many uses in industry It supplants expensive tongue and groove connections, dowels, nails or serews dovetails, rabbetting, and lapping in wood working Eventually it may supplant also outs, bolts and cap screws for connecting parts of even the heaviest metal machinery The basic simplicity of the Homer Spline Lock may be seen in the small diagram which accompanies this item. The splines for keys) are inserted in the matched grooves of blocks A and B in an ingular relationship to each other. The result is that



Above: Two blocks are firmly jomed together by means of a simple pair of keys or splines inserted in the positions shown in the lower part of the drawing. Below How the spline lock system may be applied to a drop force or pile driver.



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the two blocks are bonded firmly in the desired face-to-face position. Depending upo the kind of wood used, this method yields three to ten times more strength in the joint than is obtained by ordinary means. By increasing the thickness of the metal, wood, or plastic splines, it is obvious that friction and tension are increased in direct ratio, even to the point where the two pieces A and B become immovable in relation to each other.

It may readily be seen that splines of this type, but made of steel, could be used, for example, to fasten the cylinder head of an automobile engine or the parts of a heavy pile driver. Already they are being adopted on the manufacture of window sashes, doors, and inlaid floors. In this latter use the splines lock the pieces of flooring rigidly and thus chminate the movement and squeak so often necuniered. Furniture of all kinds may be given greater rigidity with Homer Spline Locks than with any amount of bracing

APES NOT STUPID-

INST. HUMAN

MRS APE can learn by aping Mr. Ape nut because of sex difference but apparently because it is hard for a dominant ansmal to take lessons from a submissive one This observation of ape ways, of possible implication in education of their human relatives, was reported to the Southern Soctety for Philosophy and Psychology by Dr. James H. Elder, of the Yale Laboratories

of Primate Biology at Orange Park, Florida. Despite popular notions, it is quite a trick for an ape to crack open a stubborn coconut. He can roll it around and fumble with it for a long time without getting anywhere. Only once did Dr. Elder find a chimpanzee that could crack the nut by his own efforts: that seemed to be a happy accident
It takes a firm hold and a sharp pound

against the concrete floor to crack a coco-nut. After Dr. Elder had allowed his clumpanzees to struggle alone until they gave up the problem, he showed them how. Two apes learned in just one demonstration. They could then show other apes how, and they can learn just as quickly from each

But in two eases where the ape "instructor" was demonstrating for a dominating animal, the pupils could not learn even after as many as 16 demonstrations. These two poor learners were not stupid, either; one, in particular, was very intelligent .- Science Seruce.

"Z" NICKEL

OMPARABLE with oil-tempered steel in strength, stiffness, and hardness; tensile strength from 2½ to 4 times that of structural steel; resistance to wear equivalent to that of hardened steel-such are the claims made by the International Nickel Company for their recently announced "Z" nickel wire and strip.

Being 98 percent pure nickel, the metal is rustproof and highly resistant to corrosion rustproof and nightly resistant to corrosion and oxidation. It is suited for parts which must have a high order of mechanical prop-erties, together with corrosion resistant and rustproof properties. It is useful for springs

spring washers, diaphragms, wire brushes, leader wire, fish hooks, camera parts, air-plane strut wire, portable aerials for cars and boats, and other parts of electrical and mechanical equipment.

Because of higher strength and stiffness, "Z" nickel is useful for improving performance, reducing weight of parts, or both.

INCENIOUS RAZOR BLADE SHARPENER

NEW blade sharpener, with rotary honing action, hones and strops both sides of both edges of any Gillette type blade in one operation. It is a precision instrument, engineered to improve a blade edge and keep it in smooth shaving condition

Refer to the illustration. The touth shaped hones are inclined inwardly so that the grinding surfaces of the inter-engaging grind-



Just slide the case

ing treth together form a grinding angle corresponding to the cutting angle of the razor blade

With a blade in position on the pins and the case closed, the blade rests with equal spring pressure from all four inclined granding surfaces for simultaneous operation on the four sides of the cutting edge. Then, sliding the case up and down the string, the ecrentric pins cause the blade to force apart alternately the two sets of hones, producing a reciprocatory movement of the blade on the hone surfaces. Result a smooth edge for every shave New blades are improved by honing off the tiny metallic "fuzz" often left on them

The case of the Blade Master is smart and compact, being of durable Bakelite. The hones are made of a mild abrasive material with a binder, built to last indefinitely. The metal parts are cadmium plated and rust-

TRICHINELLA SPIRALIS

THERE seems to be a widespread misun-A derstanding regarding the life cycle of the trichina parasite, Trichinella spiralis. This false impression was reflected in our recent article "Animals Bring Us Diseases," in which the author wrote that those parasites ingested by the eater of pork products are the only ones to be found in the human body. The editor who handled that story unfortunately let the statement stand. We are glad, therefore, that we can give below an authoritative statement regarding the life cycle of this parasite, from the U. S. Public Health Service:

"Following the ingestion of uncooked or undercooked meat containing viable trichina larvae, the larvae are freed from the cysts by the action of the gastric juice. They then migrate from the stomach to the small intestine of the host where they develop rapidly

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to maturity. The sexes mate within the course of a few days and the adult females begin to produce living young on or about the fifth day after infection. These young larvae very promptly enter the general eir-culation of the host and are carried by the blood stream to all, or nearly all, of the voluntary muscles of the body. Larval production by the adult female worms continues to take place for a period of approximately six weeks following the beginning of parturi-

OIL-PROOF INDUSTRIAL

WiTh the rapid development and wider uses of mechanized material handling equipment, there has been a marked increase in the use of rubber tires on trucks and trailers used in intra-plant hauling, according to Wilson C Bray, manager of The B F. Goodrich Company truck and bus tire department

"A new industrial tire, specially compounded to resist the action of animal, vegetable, and mineral oils, to be known as 'Oil-Pruf,' is now introduced," reports

Mr Bray.

"Tires of ordinary construction, when subjected to oils, disintegrate and become soft and spongy. Under such conditions, they are susceptible to rapid tread wear, cutting, and chipping Tests carried on for several years in steel mills and by meat packing companies prove that these new tires re-tain their original physical properties approximately 30 percent better than others tested when used in the presence of oils and other solutions usually classed as rubber solvents.

"The 'Oil-Pruf' tire should be a boon to companies operating industrial equipment over floors saturated with oils and greases Tests actually prove that the added service to be expected more than offsets the small additional charge necessary to cover the high cost of special materials which give the tire unusual properties," the rubber company sales official said,

SEEDLESS WATERMELONS

SEEDLESS watermelons have been produced by treating the unpollinated flowers with naphthalene acetic acid The melons were all seedless but varied in shape Some, however, were normal in shape and size The texture of these fruits was firm and solid No difference in flavor could be detected from normally pollinated fruits. The work on these fruits is being done by Cheong-yin Wong at Michigan State College

PLASTICS FUSE "WOVEN WOOD"

PANELS made with permanently finished wood veneer, fabricated by treating skilfully woven strips with plasties, are now available to furniture designers, interior decorators, architects, and others interested in a finishing material which combines dura-bility with beauty The Parkwood Corporation, in conjunction with engineers of Gen-eral Electric's Plastics Department, made the new panel material available.

The veneer is coated and impregnated with G-E Textolite resin varnishes and a remarkable toughness is the result. After cutting



the veneer into strips of the desired width, close, accurate weaving is possible. But further treatment is necessary to fuse the woven sheets into satin-surfaced, durable panels that can be cut and worked within practical application

In order to produce such panels, the woven sheets of impregnated wood veneer are cut to the desired sizes and are bonded to Textolite laminated material uniter heat and pressure The desired tough, resilient, and smooth surfaces are the result

The finished panels, in thicknesses of 3,54 or 0 020 meh, have a variety of applications Mounted on ordinary plywood or other solid



Table top of woven wood

backing, Parkwood Textolite constitutes a fine new finish for such objects as desks, card tables, cabinets, bars, walls, and ceilings Unaffected by moisture, alcohol, fingernail polish, and most common acids, the material is also resistant to eigarette burns. In the 0.020 inch thickness, it is surprisingly flexible and can be stitched, stapled, and cut with ordinary shears, like a piece of leather in either thickness it can be formed, cut, and entitled by ordinary woodworking methods

A panel of Parkwood Textolite, after the final treatment, has a surface almost as smooth as glass and a pattern that looks like a fine, highly polished mosaic Numerous effects are available through the combination. in weaving, of various light and dark woods Panels are ordinarily made with light or dark red mahogany, avodire, a golden-shaded wood imported from the Ivory Coast of Africa, birch, either red or white, New England maple, and walnut

BACTERIA IN WATER MAINS

T has been found that bacteria multiply in hemp. For this reason a rubber compound made in tubular or wedge-shaped sections is replacing jute and hemp as caulking materials for water mains Tests have shown that sterilization of hemp and jute can be accomplished, but bacterial multiplication starts again as soon as the germicidal action ceases.

NEW LIGHTWEIGHT INSULATION

NEW product named Celotex Superlite A Insulation, which should be of special interest to the refrigeration field, has just been announced. It weighs less than 71/2 pounds per cubic foot but high insulation and sound absorption values are claimed for st. It is of board form, but is a soft, nonstructural insulation. It may be fabricated, cut, or bent to moderate curvatures to fit



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New Bloc Cub weighs only 8½ pounds, costa only 2c an hour to run. Now, a complete lina of 6 Elto models—built by Emirade—offer outeranding quality; at low cost. Write for free Evintude and Bloc catalogs, Boat Directory, Boet & Motor Selector.

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engine-divided on white celluloid, with glass-"frameless" indicator, and is packed in a case with book of instructions.

The Langener combines many rules in one although there is only one slide. The face has six scales. Two of them above the slide represent feed, length of cut, and diameter, three of them on the slide represent revolutions per minute, time, and cutting speed, the regular D scale is below the slide. The reverse side of the slide contains the usual B, CI and C scales, for standard slide-rule calculations Three of the face scales are numbered in red, the remaining three in black, for convenience in use. The table on the back presents familiar constants

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STREAMLINED TURKEYS

THE sim of certain turkey-breeding work is to develop a small turkey to fit the modern small oven and suitable for the modern small family, according to Berley Winton, in charge of the Department of Agriculture's poultry-husbandry investigations. There is a

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Stegoseurus Sez Horse

Send for our complete illustrated list SELLRIGHT GIFTWARES CORP. 836 Gates Avenue Breeklya, N. Y. growing demand for small market turkeys, he says. The smaller turkeys out of the annual crops of the standard varieties sell at a premium of ½ to five cents a pound.

It will take probably another five years before the desired characteristics are "fixed" in the new small-type turkey. Winton points out For that reason, the Department will distribute no breeding stock, batching eggs. or poults until the geneticists are satisfied that the small type turkey is "genetically pure" for small size and other desirable qualities, and able to reproduce itself true to type, in the future

The Department geneticists want to establish in the new turkey the small size of the white Austrian variety imported from Scotland and of strains of wild turkeys from \nginia, Pennsylvania, Michigan, and Arizona They hope the new turkey will also inherit the meaty breast of the wild turkey

To reinforce the inheritance for white olor, the geneticists are using the white Holland in the hreeding program to produce the small-type turkey. They are also counting on the white Holland-and two other domestic varieties, the bronze and the black to contribute early maturity and other desirable characteristics

If the Department men succeed, the smalltype turkey will be white, with a compact hody, short legs, a long keel bone, and plenty of breast meat. It would mature in 24 to 26 weeks, the young hers weighing 61/2 to 9 pounds dressed, and the young tons between 11 and 151/2 pounds dressed.

Other goals for the new turkey are that hens kept for lireeding purposes be able to produce a reasonably large number of eggs by June 1 Ninciy percent or more of the eggs would be fertile and 80 percent or more of the fertile eggs would hatch

INSULATION OF GLASS FLUX AND MICA DUST

I N the German electrical industry, a new insulation material, now in use, is composed of a combination of glass flux and mica dust. It has the advantage of being extraordinarily firm, maintaining a high heat content and a minimum of dielectric current loss. This material is important in high-frequency technique and in the manufacture of electric switches

COSMETIC TO PROTECT WORKING HANDS

NUMBER of skin protective creams A NUMBER of skin protective creams— sometimes called liquid gloves—have heen on the market for years. These have been used to protect the hands of working-nien against the action of various kinds of chemicals, paints, and solvents.

A new compound for this purpose, called "Shelltex," is made of such pure ingredients that the manufacturers claim that it is even safe to eat. In using this, the workman first washes his hands thoroughly and dries them, after which he applies a liberal quantity of Shelltex and rubs it in until the sticky feeling disappears. This one application shields the skin from dirt, gasoline, paints, inks, lacquer and lacquer thinners, and most sol-vents. The flexible film on the hands does not interfere with work and 18 easily removed by washing with warm water and



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PHOTOGENIC NEW YORK WORLD'S FAIR

THEX just couldn't usstret the anatem. The New York World's Fair was too full of good picture material to say to plot outputs with the material to good picture material to say to plot outputs with the same of t

But the best stuff is conflower, and that is all to the good because there is molting to be at sandpilt for general shooting. There is one hazard in this connection lowever, and that is the fact of dependence on the squaies of the washer? Under a model to and grace to shorts of the Fan buddings. In he of clouds for three seem always to be absent on just the day you happen to visit he Fara, a courtes; thirt with a the orange will go a long way by providing a dark tone the Bard and the stuff of the seem of pertines to the blank sky, thus avoiding the white paper effect that is the larne of pertines filter was used in making the whot of the principal illustration for this article. The exceent shadow of the Typlon case across the Sphere invited photographic attention but was not until the viewpoint shown was rached that an interesting composition presented used. Clouds seemed imperative, but the orange filter supplied a good substitute, in fact, a substitut that was very appropriate to the scene.

The Theme Center, consisting of the Persphere and Trylon, may be seen from most sections of the Fair grounds in majestic



"Archery at the Fair"



"Pageant of Stone"

reign over all the activities within the was area. Doublews the majority of pretures taken of the Far ruther noticule the Theme Center within the view or make it the sole subject of the perture. One might easily some feature of the Far with a view, near make up a whole series of short ying say some feature of the Far with a view, near or runte, of the Thirm Center, Small stops will often be necessary, as in the case of "The Timer Center, Small stops will often be necessary, as in the case of "The Timer Center Percudes All," but small stops are easy at the Far, where the presence of so many light-toned bouldings under a wast sky makes small stops or very short reposition.



use the new fast films in order to take care of indoor situations and the possibilities to come at night

Frequently one rons across isolated bits of scolptine such as that of the winged subject illustrated here. This was taken against the son, with the latter positioned directly behind the base support of the subject "Archery at the Fair" os an example of the

"Archery at the Fair" is an example of the sort of picture that will require several shots in order to make a later selection of the most interesting arrangement. In this particular case, the three most attractive figires in the line up were chosen as the main point of foots.

point of fector.

Night showting at the Fair is cessly accomplished with the fast films and fast lenses, Most shows will be in black and white, but you will be missing the "opportunity of a letterine" foy due not attempt some color. Exposures are relatively long but the binds and the state of 128, white other shipers, such as the color display in the fountains, will call for exposures at this stop ranging from 1/5 or * \$45 to 1/25\$. Cheen or similar camera supports are in order For many cameramen the World's Fair is most attractive at night cheefly because of the color highly angle.

Needless to say, a good film supply is the best insurance against running short just when you're getting into the awing of the thing. If you plan to carry an extre camera for color, plus accessories, one of the popular combination "catch-all" zipper bags will be found handy.

Uses for Blue and U.V. FILTERS

ALTHOUGH little publicized as compared with the yellow, red, and green filters, the U.V. and blue filters are found useful as several different ways. The U.V., for example, is employed to cut out haze when it



"The Theme Center Pervades All"

is not possible to employ other filters, for the purpose because of the longer cynosire required For example, if the lons is stopped door accorded rayly and the meter was to give 1.25 of a second, it would not be possible to use a filter unless a tripod were available for the yillow or red filter would call for a with the camera bed in the hand. The UV, filter omes in handy in such cases because it does not exput, any increase in exposure.

The blue filter band us greatest overfulness in indoor photography. When subjects has ung a fair skin are photographed by artificial high on panchromatic thin, the resilts do not always show pleasing field tones. We have found that the new of the blue filter placed over the lens greatly uniproves the results Annohra we for the blin filter is in the projection of two by two-and to older slides. We have processes we calculate find that the same processes we calculate find that the Shipping a blue filter over the bras has resulted in uniprovement of the color values.

How Cartoon Movies Are Made

This made story of cartoon movie making is depicted in a linerval flowin film, "Cartoonland Mysteries," by Lowell Thomas, now available on rental from the Bell & Howell Filmosumd Library Told in complete detail is the story of the making of an Oswald Rabbit cartoon, entitled "Softball

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obvisting druurbance during an operation, and expoures remade by a nurse stationed as a distance from the operating table. Upon order from the surgeon she preses an electric push-button which trips the camera release, the camera state thereupon automatically set itself for the next expoure. The camera is coupled to the operating on the state of the state

In use, the camera is pre-focused, thereby

DESIGN AGAINST THE SKY

THE extreme usefulness of the reflex camera under particular circumstances was demonstrated the other day when, strolling in the park, we gazed upward and saw outlined against the sky the beautifully curv-



"Design Against the Sky"

ing branches reproduced here. The peculiar formation was directly overhead, and, with the reflex camera we happened to be carry-

ing, it was a simple matter merely to hold the camera so that the lens was pointing directly upward, while we observed and composed the subject at eye-level position without straining the neck

SHOOTING AFTER A

DAMP NIGHT

AMATEURS containes complain of undataproses appearing un one picture while the very next exposure seems to be perfectly satisfactory. Thus may be due to any one of a number of causes but one of the reasons not ordinarily realized is that when a loaded camera has been exposed to a night of dampees or ran, the film is inclined to warp a little, causing unevenness of surface The renedy is to wate one shot and thus get rid of the first film frame, going at the third of the first film frame, going to the third the film frame, and the follow ut with another just to see what the results are.

THE DIVING CYCLIST

AT a stated hour, announced long in advance, cream "axis of daring" and so forth are performed in the anuscement parks. The picture of the diving overlist was made at Rys Beach's Playland. A position was assumed that would include some of the spectators, and a small enough stop was used —//11 being found sufficient—to show in satisfactory sharpness both the rapidly moring whiject and the spectators near this

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of people

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Oivisien 3 Action—including alt types of photography in which ection is the predominating feature In such division there will be prizes of two Longines watches—The World & Most Resource World—and two Fed Set Enlarges, as well as fire Hoon:

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Photograph Contest Editor, Scientific American

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he Diving Cyclist"

camera. The reflex miniature camera used was held high above the head with ground glass speide down and the shutter suspeed as the bicycle left the runway Since it was desired to get a somewhat off-sharp image in order to retain the effect of movement, a shutter speed of only 1 100 of a second was used

THE MORNING STROLL

TUST after the hose had been played over the sidewalk, about 7 o'clock of a June morning, the sun, reaching over the city buildings, swept the stones with its smile A viewpoint was adopted by the photographer



"The Morning Stroll"

which would bring the light in his direction This afforded a better tonal effect and the shadows of subjects passing to and fro came in the diagonal direction desired. A man and a dog out for a stroll was an agreeable subject, and the picture you see is the result.

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submitted must depict the thenic of balance in some way For example, a photograph of a boy balancing himself on a narrow fence. a newhorn hahy being weighed in a scale, or the balance of a sailboat turning gracefully in the wind. Cash prizes will be awarded

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By Proxy for the Sun

A STRONG reflector of light will behave in practically the same manner as the light source itself. For example, we are all familiar with the path of light cast by the sun across a body of water. In the picture reproduced here, taken from a feeryboat a-



Light reflected from windows of one of the tall buildings in the background was strong enough to produce this "sun path" effect

it approached downtown New York City late one afternoon, the windows of the tall hilldings all reflect the sunlight, but in one or two places, this effect was particularly strong In those places the result was a glare, and the long "beam" cast upon the water is very similar to that which the sun itself

PROOF OF THE PURDING

WHEN it's your "yes" against the other man's "no," let the picture decide the issue At least that is the way one deter-mined chap booked at it Recently, a camera owner who had found that the foot scale on he outfit did not check with the ground glass, came with his complaint to the camera emporter There the repair man told him that he had checked the camera and found it to be O.K. The customer had his doubts He set up his camera on a tripod and used for subjects a number of books set on end. the tacket cover side facing the camera. The books were carefully spaced, with a ruler. six inches apart, and the distance from each volume to the camera also similarly measured. A photograph of the set-up showed that whereas the scale read five feet, the book

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at this distance was out of focus, although the book at six feet was in perfectly sharp focus. When he brought in this "evidence" he did not have to say a word. The picture told the story.

PIGEONS AT REST

In the city pigeons are everywhere, most appropriately in the public parks. With the squittels and the ducks, they are continually being fed, and often photographed Frequently they may be seen lined up in a row, as in the illustration. An angle shot,



"Pigeons at Rest"

with the lamp offering an agreeable accent, and the few leaves in the upper left concer-"filling in" for balance, brought the subject into a reasonable composition. Too, the pigeons are neely spaced so that the interes is spread across the entire length of the diagonally placed lamp-post xtension.

HANDY RECORD BOOK

BEFERN(Es to formulas, methods, and other photographic data are made easily as cessible suit the Rech-Record, a visible and made system available in poket sor the individual cards measure 2½ by 3 inch es a quarter inho edge of each being left uncovered for the index The card, while trainers until affords seningly room of a formula or process, as well as flash exposite data, and so on The book may be carried about in the pocket and whenever int runs across a new formula or other information that may prove useful later either in shoot in printers of advisions work, the record can be made immediately. At work such a morleads can moreluse from vanishilate morleads can be made immediately.

BETTER GET STARTED!

CONTEST thoing dates have a way of the covering store that the covering store to the old expression: "Where has the time gone to "In the case of the Fourth Annual Scientific American Photographus Contrest, the choung date was purposely placed far enought in advance to enable every not to make adequate prefarations for submitting their per prints. But therein her possible source of difficulty. With the change possible source of difficulty with the change that the change is the chance that some amateurs are going to think that there is so much time for preparations that they will put things off until the last minute and heuce fail to reag the in

Bass Bargaingram

VOL 29 179 WEST MADISON STREET CHICAGO, ILL NO 8

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Bass returns
from the N. Y. World's Fair to report that
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Shutters pop on all sides—miles of film
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Charles Pars

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tended benefit of the preparatory period | BOOKS permitted. Therefore this warning.

Now, right now, is the time when you should be looking for subjects that will be eligible under the rules of the contest, published in full in our May 1939 issue With no dead-line pressing, you can select and reject at leisure, improving your technique as you go along, every improvement increasing your chances of winning one of the major prizes Then, too, last minute dark-room rushes are not usually up to the desired standard Take your time to turn out work of which you will be proud. But, above all, don't fail to enter the contest, and be sure that your prints are in the hands of the judges in tim

WHAT'S NEW

In Photographic Equipment

Cill you are interested in any of the stems of easy robed below and cannot find them in our advertising columns or at your photo oraphic dealer, we shall be alad to tell you where you can our them Please accompany your request by a timped circliop.

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ter to be set and film transported without iemoving camera from eye, making possible a dozen shots in few seconds Winder is attached

by unscrewing shutting winding knob, replacing it with special geared knob and screwing bracket into cable release socket on top of camera. Entire unit detachable in less than one minute

SKINNER RESTITUTIONAL ENLARGER FORtures negative adjusting device enabling operator to tilt negative from horizontal plane, optical system always remaining in perfect alignment, double condensers, takes negatives from 21/4 by 31/4 inches down to 35mm.

NLW STANDARD 6 by 6cm ROLLEIFLEX (\$128.50): Taking lens is Zeiss Tesas //3.5; finder lens, f.3.1. Cumpur shutter speeds to 1/500. Shutter speeds and disphragm openings visible from above, through one window, adjustments being made with two levers, one on each side. Automatic film transport after locating No. 1 in red window.

BOOKS

r Amateur Photographers

New Ways in Photography, by Jacob Deschin. Eminently practical from every point of view, this new hook contains nothing of theory and nothing that the advanced amateur photographer will not find valuable in one way or another. It covers the in one way or another. It covers the whole range of amateur photography, discussing surh things as trick pho-tography, photomurals, retouching, infra-red, and a number of other sub-divisions that will not be found elsewhere in as clear and concise a man ner, \$2.85.

SO YOU WANT TO TAKE BETTER PICTURES, by A. P. Peck. A friendly, factorine chair with the camera owner who has his developing and printing done at the photo shops, yet wants to know enough about his comera and its uses to enable him intelligently to utilize it to best advantage. Over 200 pages, dozen of illustration. \$2 10.

UNIVERSAL PHOTO ALMANACAND MAR-LET GUIDE. How, when and what to photograph in order tu make muney with your camera; where to sell dif-ferent types of prints. \$1.00.

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CHAMPLIN ON FINE GRAIN, by Hurry Champlin, A consplete hand-hook on the entire subject of fine grain, in-cluding formulas and how to com-pound and use them. \$1.85.

PHOTOGRAPHIC HINTS AND GAUGEIS, by Fraprie and Jordan. How to moke all kinds of photographic accessories; from film clips to cameras to lighting equipment, and so on; 250 articles and neorly 500 illustrations, 33.60.

POSTRAIT PHOTOGRAPHY, by H. Wil-liams. Fundamental principles of composition and lighting, paving the way to satisfactory results in this particular branch of photography, 81.35.

PHOTOGRAPHIC ENLARGING, b/ Frank-PHOTOGRAPHIC ENLARGING, b), Frank-lin I, Jordan, F. R. P. S., One of the most interesting and authentic books on enlarsing. Its 224 pages cover every phase of the subject and 75 illustrotions, many of them adon-sinuers, shout the value of correct technique, \$3.60.

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ELECTRICAMERA (\$8.75): Is a complete box camera with an electrically operated shut ter synchronized with an Abbey Flashgun Because of the basic-



ally new principle involved in synchronization it is practically impossible to miss the peak of the flashbulb. Any flashhulb may be used, regardless of timing characteristics, because the electrical

shitter automatically catches the peak Electricamera allows for side lighting, remote control, and other features associated with more expensive equipment

VICTOR ADD-A-UNIT ANIMATOPHONE: 16mm motion picture and sound apparatus permitting adding additional units as desired Starting with small basic sound projector, complete in itself, outfit of any size can be secured by adding auxiliary units. Basic projector provides silent or sound motion picture, microphone facilities, and phonograph record amplification for average size room. Adding amplifier and another larger size speaker furnishes ample sound motion picture or public address facilities for large auditorium Broadcasts, recordings, and announcements may be relayed to as many rooms as desired when Central Radio P. A. Sound System unit is added.

Zeiss Tenax I (\$60): Makes 50 pictures one by one inch on 35mm Contax daylight loading spools Features a lever that winds



both film and shutter, Exposures possible at rate of one per second for sequence picture-making. Equipped with Novar 1/35, 3.5cm focal length lens.

field afforded by this lens, when focused at 8 feet and stopped down to //16, depth of 8 feet and stopped down to //16, depth of 6 feet detends from four feet to infinity. Comput shutter from 1 second to 1/300, and bulb. Fitted with large eye-level optical view finder. Rewind device provided for other than contact spools. Exposures automatically counted. Lock prevents deable exposures. On the contact spools of the counted for
MELLOWBLAM LIGHT DIFFUSERS (\$1.75 to \$6): Features new "light-carrying" material Lucite. Can be supplied for all models of Victor Lighting Units. Use of Lucite in combination with, Fibroglas held to be of particular value when used in color photogramy with the combination with the color of
not change color of light source. Claim is made that these diffusers provide good light distribution properly diffused, retaining its original characteristics under prolonged use without distinguistic of discoloring from heat or age. Exposure time recommended is twee that of undiffused light.

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ing subject in perfect focal plane with camera. Camera support affords universal adjustment of camera position, both vertically and horizontally. Camera supporting arm fully counterbalanced. Movement up or down the post controlled by over-

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JACOB DESCHIN, conductor of our "Camera Angles" department, while masser in these columns, questions of period interest to amotive programmers. If an answer is desired for mail, incluse a stampel, addressed or draw comparisons between manufactured products nor to advise on the purchase of equipment or materials—The Edition.

Q. We are obtaining equipment to take pictures in color of pathological specimens such as livers, hearts, lungs, and so on, of poultry for the purpose of projecting same on screen. All work will be done by Photoflood illumination because of the constancy of the light source, Reflected light from the object will be measured by an exposure meter at 12 inches. Questions: 1. Should the object he illuminated by one Photo flood lamp directly over the center or two lamps so placed as to illuminate from the sides? Since the specimens are moist, there will be streaks or spots of intense light on them. How can these be climinated? 2. What general or specific rules would you suggest in respect to the color and type of back-ground, and what kind of material would be suggested for the background? 3. The writer has been advised that the smallest opening or higher "f" value gives the greatest detail in the picture. Is this the general rule and may the smallest opening be used? What difference would there be in the resulting picture between an object strongly illuminated at short exposure or moderately illuminated at a correspondingly longer exposure? 4. What "tricks of the trade" are recommended for obtaining third dimensional effects? 5. On the table of film speeds we have, two values are given, one for sunlight and one for tungsten. In which classification would Photoflood and Photoflash fall? 6. Is Photoflood illumination satisfactory for Kodachronie film in bringing out good color copy?-S. A. R.

A First, we must question your use of the word "constanty" in describing Photoflood light The intensity varies with use, growing weaker from one time to the next The measuring distance will depend on the size of the arcs being photographed Centrally speaking, the measuring distance should be roughly equal to the width of the subjuct, that is, if the subjuct necessares say by eight that is, if the subjuct necessares say by eight the subjuct in the subjuct necessary and the subjuct n

sources should do the trick of entting down the effect of strong light on moist specimens 2 Use a background of medium gray or somewhat lighter tone. The purpose of a background is to afford an area of contrasting tone to that of the subject being photographed so that the latter will stand out clearly. The material used is of no consequence It may be cardboard or felt cloth, the latter is most widely used by photographers 3 The greatest sharpness of a lens is generally about two stops smaller than full aperture but greater depth of field and more details in sharp focus are obtained by stopping down the lens consulcrably, even to the smallest opening. For subjects such as yours and particularly since you are photographing in color, where sharp detail is important, the smallest opening is to be advise I Strong illumination as compared with mod erate illumination is not entirely a matter of exposure, better tonal quality and diffusion of light into the shadows will be had with moderate lighting-and usually the reverse with strong lighting 4. The best "trick of the trade" we can think of is to use a stereo camera Short of that, we might suggest "playing" around with the lights, making one a little weaker, or moving it farther away, than the other. 5 Photoflood lighting comes under the tungsten heading Photoflash cannot be measured, exposure being governed chiefly by a table of distances available from your dealer or the manufacturer of the flash lamps you are using 6 Photoflood lighting is the most widely used type employed in color photography.

Q. Does an cutomatic film transport permit a camera to take sequence shots? If not, what does determine if a camera will take sequence shots? After all the film is exposed, isn't it best to develop it right away? A friend sava it does not matter if it is developed event when the control take. Who is corcert? What other kinds of range finders are there. J. N. B.

A It is not increly the automatic film transport that permits a camera to take the rapid sequence type of pictures you evidently have in mind, but the fact that shutter wind and film transport can be accomplished with innusual rapidity. Sequence pictures can be made with any camera having the couvenience of automate film transport combined with abutter ward, the number of abots within a given period depending on the type of abutter wind and the abulty of the photographer to work the controls rapidly Special sequence cameras are available on the market group givetures on enth square and 50 to the roll. Streetly speaking, these are the only time sortled sequence cameras, which were the speaking of two miniature cameras, which were the speaking the speaking these speaking the speaking

It will do no harm to delay development of a roll of film for a reasonable time, say a mouth or so

The coincidence type of range finder, in which two overlapping images appear, sharp focus being achieved when the two are superimposed or coincide, is the other principal type.

- Q. Can you give me a rough idea of how many four by five-inch prints can be developed in 16 ounces of metolhydrochinon developer before it has to be disearded?—C. W. G.
- A Under favorable conditions that is, inhampered by such luzards a secedental transfer of hypo In the finger tips, and so forth—about 75 prints of the size you mention can be developed without clonge in developing time or print quality, using 16 ounces of MO developer.
- Q. Enclosed is a negative showing the reflection of a lighted electric sign projected onto the sky in a night view of a city laudscape. Can you tell me the cause of this reflection and how it can be remedied in the final print?— 1.1.K.
- A The reflection you refer to is exactly the same as that idealined when shooting thereily into a light source. Internal reflection between the lens surfaces is the cause fitted thouse of the reflection, it will be an easy matter to spot it out if furnited on non-slower paners.
- Q. I am going to purchase a folding type camera with f 4.5 lens that takes pletures 2½ by 3½. May I have your opinion on the quality of the lens and shutter equipment of the cameras I am listing? How do the three lenses and shutters compare?—C. V.

A State we are not in a position to a state of a camera up against another, it is not one camera up against another, it is not possessed to a recommendation from the standard not be conditioned to choose return a standard not be conditioned to the contract of the standard not be conditioned to the contract of the standard not a spanned to a top-speed of 1.250 of a second as against 1/170 non use of the other camera. As for the lenses, you should be able to make good pottures with any one of them All other things being equal, the deciding factor will be an individual ones how do the cameras appeal in you from the point of view of conviences and pleasure in handling?

Q. My... camera stops and speeds do not correspond with those on my ... exposure metter. Can you advise me how to use this meter scale with my camera?—C. G.

A. It is generally more advisable in photography to give the longer exposure rather than the shorter one. We would suggest, therefore, that since the meter does not indicate a

speed of 1/75 of a second, you either use your 1/50 speed and ignore the 1/75 or adjust your disphragm indicator between stops, should you want to use the latter speed Similarly for the 1/200 speed, which does not appear on the meter scale As for the stops, the scale stop f/28 can be used for both f/25 and f/3 on your camera; the scale stop f/4 for f/55 and f/55, and the scale stop f/6 for f/55 or for 1/55 or for lowing stops to nymir camera f/9, f/125 and 1/18, respective.

Q. In order to obtain dark sky effects I wish to buy either an orange or a red filter. Will you please advise me which is the better one to buy?—I., K. M.

A Sometime go the red filter was usually recommended to this purpose, but more recently the orange filter has taken its place in the popular factor One of the resons is that the orange filter has a lower exposure factor than the orange filter has a lower exposure factor than the red; in fact, it is usually about half, the red requiring about eight must be normal exposure, the orange only four Another reson is that the red filter decision of the red filter of the red filter or
Q. When I wish to cut off part of a 35mm roll in my camera in order to develop a strip of film before the entire roll has been finished, how many frames must I lose in reloading the unused portion?—D. A.

A We estimate that in reloading the imused portion of the roll of film after cutting, you will necessarily lose about three or four frames

It does sometimes happen that a few printare desired in a lintry. Many photographers, however, buy bulk film and had their own riels with lengths of film which will be economical and convenient for the subjects to be shot.

Q. Can you explain the meaning of the term "genre" when used in describing a type of picture?—A. F.

A This term refers to a picture that tells a story For example, two children at play, a laborer at work, the portrait of a woman knitting or engaged in some kitchen chore, are typital gentre pictures. In short, any picture that shows a person engaged in doing something is properly classified as of the genre type.

Q. I am enclosing some prints and films; the prints have dark spots caused by corresponding light apots in the films. I have my developing done by a local concert and these spots seem to occur at random on different rolls. Some have suggested the spots were caused by error in developing and some hy dirt or dust on the lens.—B. V. C.

A. As examination of the organizes does that the hals spots to which your refer are undoubtedly caused by incomplete develop ment at those points. This may have been due to negatives stecking together at the particular point and preventing full development or development blocked locally by some other unterference. The fact that the image is almost fully revealed at these points by the properties of the properties of the pointcular point in question prevented a density comparable with the res of the negative.



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ENTIRE space in this month's department is given to an informative article on "Some Applications of the Schmidt Principle in Optical Design," by D O Hendrix and William H. Christic, of the Mount Wilson Observatory of the Carnegic Institution of Washington The former is Assistant Optician in the Mount Wilson Observatory Optical Shop and Oppician for the Foundstion for Astrophysical Research The latter is an astronomer on the Observatory Staff, specializing in stellar spectroscopy and com-



Figure 1. Bernhard Schmidt's first Schmidt camera photo, now historic

puting He also takes active interest in instrument design. The following is the article by Hendrix and Christic

O'E of the most outstanding inventions in optics of modern times is to be eredited to Bernhard Schmidt, late optician of the Hamburg Observatory in Bergedorf.
The first Schmidt camera saw the light of day one sultry afternoon in the late summer of 1930 Using the camera as a telescope, Schmidt and a friend amused themselves that afternoon by reading the epitaphs on the tombstones of a nearby cemetery, and by looking at various buildings in the distance Among other objects was a windmill about two kilometers away, in Figure 1 the reader will see the reproduction of a photograph of this windmill, made by Schmidt with the first Schmidt camera. This photograph was made on a moonless night with an exposure of two hours. On the original print one can actually count the twigs on some of the distant trees

As in most great inventions, Schmidt's method of eliminating come and aberrations from reflecting telescopes is simplicity itself and, as one looks back, it seems incredible that no one appears to have thought of this smple solution long ago Several articles have been written about

the Schmidt camera since the inventor set forth its principles in 1931, but little that is new has been included in these discussions. Since there are many ramifications of the schmidt principle it has seemed worth while to discuss this remarkable camera and its applications fairly completely, for it will be found that there are but few fields in optics where this invention cannot be applied to some advantage

The outstanding defects in the images formed by lenses and mirrors are spherical aberration, coma, astigmatism, curvature of the field, distortion, and for lenses we have, in addition, chromatism. Of these defects, only one is distributed uniformly over the whole field, this defect is spherical aberration. all other defects are proportional to their distances from the axis

Now a spherical porter has no axis and furthermore, a mirror is perfectly as bromatic so, could we but find a method of eliminat ing spherical aberration from the images produced by a spherical concave mirror such a

system should prove ideal

Spherical aberration is caused by rays from various zones failing to come to the same focus, the more distant the zone is from the central ray the closer its focal plane is to the mirror This defect, for spherical concave mirrors is shown diagrammatically in Figure 2, at A Suppose now, we place a very small aperture in a sereen at the center of curvature of a spherical concave nurror, as shown at B. this aperture will limit the size of the mordent beam so that the center and outer zones will come practically to the same focus for it can be hown that, for small apertures, and focal ratios less than / 10, the Rayleigh limit of λ/1 is not exceeded. If the incident beam be swing about the point o, all parts of the mirror will be illuminated in turn and the focus will trace out the spherical curve, fl. which has its center at o It will be seen that each point source of light toward which such an optical arrangement might be turned

On increasing the size of the aperture the focus is no longer sharp spherical aberration is now appreciable, but we can eliminate this defect by introducing equal and opposite aberrations into the incident heam as shown in C These opposite correcting spherical aberrations may be produced by a suitably shaped lens, or mirror, placed anywhere in the parallel beam for one particular point ree of light, but when we are dealing with more than one source it becomes im perative to place the correcting plate in a position common to all rays, that is, with the optical center at the center of curvature of the mirror. For many purposes a large field is not required and it become more convement to move the correcting plate away from this position and perhaps incorporate it with some other optical surface, such, for example, as the face of a prisin or the collimater of a spectrograph. The corrections, of course, are not identical for all positions of

On introducing the correcting plate into the incident beam of light we also introduce chromatic aherrations For moderate apertures this defect is negligible, but when we attempt to make a camera with an aperture greater than its focal length we run into difficulties; how these may be partially surmounted will be discussed later, Of course it is possible to design an achromatic correcting plate by using two plates of different indices of refraction. It is also

the correcting plate

possible—and practical—to distribute the required corrections between several surfaces when it is desirable to avoid deep or steep curvatures

The curvature of the field may be removed (approximately) by means of a simple plano-convex lens placed immediately in pie piano-convex tens piaced immediately in front of, or in contact with, the photographic plate, the plane side facing the emulsion. The radius of this lens is f/3 for glass with an index of refraction of 1.50. This is satisfactory for cameras having an / ratio of / 5 or less

Applications of the Schmidt Princi ple: In the accompanying diagrams, Figure i, we have portrayed some of the numerous adaptations which may be made of the Schmidt principle Unfortunately, Schmidt left no account of the various ramifications of his camera of which he must have thought, and we do not know, in most cases, who originated the various arrangements we present, most of them have been devised here, but we do not claim priority In a few cases, where the originator is known, we have appended his name to the diagram. although it is probable that others interested in fast cameras may have indepen dently thought of them

In the central column of the diagrams we have arranged illustrations of the fundamental types of Schmidt cameras and, to the right and left, some adaptations of these

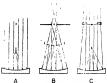


Figure 2. Spherical aberrations and Schmidt's remedy for them

types, most of which need no explanation No VI, which shows the diaphragm replaced by a correcting mirror, is shown, as are most of these diagrams, in an exaggerated form; in practice it is necessary to reduce the angle between the incident and reflected beams to a minimum in order to reduce the foreshortening effect. A perfect correcting mirror should be figured in an elliptical form but, since such a figure is very difficult to produce, we must be satisfied with an approximation in the form of a circular correcting mirror. If the aperture ratio of a camera using a correcting mirror is small, the foreshortening will be negligible, and here we have a perfectly achromatic arrangement which should be exceedingly useful in working at the extreme limits of the spectrum

When a Schmidt camera is constructed with an aperture greater than its focal length, the curves in the currecting plate become steep enough to introduce appreciable chromatic aberration. If, however, we use a thick mirror, R/2 in thickness, silvered on the back surface, as shown at IX, we increase the speed of a Schmidt camera by a factor of 2½ to 3 times, depending upon the kind of glass used, because, on passing from one medium to another, the energy-density of a cone of rays is changed by a factor equal to the square of the inverse ratio of the indices of refraction of the two media To put this in other words. since the rays, after passing through the surface of the mirror, are refracted toward the normal, they appear, as seen from the surface of the mirror, to emanate from a point closer to the axis; hence the angle subtended by an object is reduced, and the mage formed by the mirror is correspondingly diminished in size The geometrical

focal length, however, has been changed but little, and thus we can obtain the speed of an f/0.66 camera with a field and correction-plate curvature of an //1.0 camera. This is shown clearly in Figure 4, where an ordinary Schmidt camera is compared with one of the thick mirror type

In such a camera the correcting plate is placed at a distance of R/2n from the front surface of the mirror, where R is the radius of the mirror and n the index of refraction of the glass. This position is the apparent center of curvature of the mirror as seen from the mirror surface. (In all cases where the focal curve lies at the surface of the glass the photographic emulsion should have a film of oil between it and the glass, in order to make optical contact Coal-oil will be found quite suitable for this purpose)
In XII, Figure 3, we have the extreme

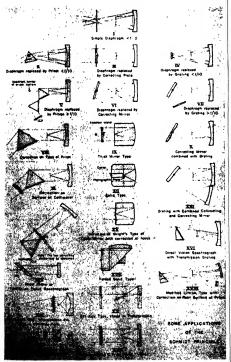


Figure 3: The Schmidt principle has many varied and interesting applications



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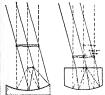
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SCIENTIFIC AMERICAN 24 West 40th Street, New York, N. Y. form of solid type-one in which there is no medium other than glass between the correcting surface and the focus. This was first suggested to us by the late Sinclair Smith We do not know of such a camera having been made and there are some practical optical difficulties to be surmounted in constructing a solid Schmidt, furthermore, the increased absorption of the thick glass becomes important, and, since it must be sufficiently homogeneous for its purpose, such large blocks are very expensive two parts, separated by the dotted line in the diagram, should be figured separately but when cemented together they must be accurately co-axial The photographic plate could be introduced into the focal curve through a hole in the half containing the



along the axis as shown

Figure 4. Ordinary and thick nurror

Schmidt camerus compared to scale Index of refraction assumed to be 2 correcting surface, either from the side or

The difficulties of the extreme thick mirror types may be overcome by a variation of Wright's ("Amateur Telescope Making-Advanced") system, that is, by placing the correcting surface at the focus as shown in XV; but here we are confronted with two non-spherical surfaces, extremely difficult to figure in conjunction with each other An experimental camera of this type, with an aperture ratio of f'l, was constructed here, but it was not a success because the higher order aberrations rendered the images unsatisfactory It is possible that a camera, geometrically 1/4, or with an equivalent focal ratio of 1/3, would be entirely satis-

One of the neatest of all solid types that shown in XVII—the folded soli Schmidt, designed by Hendrix Here we have few practical optical difficulties, although there are four components Of the seven plane surfaces only the hypotenuse of the large prism must be worked to a high degree of precision, the cemented surfaces are sufficiently accurate if worked to a wave, because the cement, which should have an index of refraction equal to that of the glass, fills in the arregularities between the surfaces. Small errors in the thickness of the components may be rectified when adjusting the small prism during the final assembly.

The "off-axis" type, illustrated in XX, is exceedingly useful in practice because, with this arrangement, the photographic plate or film may be placed outside the light beam This system also is adaptable for visual observations. Making a single off-axis correcting plate of large dimensions is, unfortunately, somewhat wasteful of time and material, because it is necessary to figure a correcting plate of more than twice the required diameter. If more than one camera of the same focal length is required, the waste is reduced, because several off-axis plates can be cut from the original one. This type seems to be the only practical one for

mass production.

In XIX the Schmidt principle is used in the form of a microscope. Such an arrangement might prove useful for low-power work where a large field is desired, such as in microphotometry, but perhaps the most ingenious arrangement is that of Hayward, XXI, in which he suggests a thick nurror with the focal curve ground out of the mirror face, and serving as a reservoir for small living organisms. An unsilvered portion of the spherical mirror serves to admit light for dark field illumination.

The Design and Construction of Correcting Plates: The deviation, A. of the surface of a correcting plate from a plane is given by the biquadratic parabola formula

$$\Delta = \frac{x^4 - kr'x'}{4(n-1)R^3} \tag{1}$$

where x is the radius of the zone, A, a constant, 7, the radius of the correcting plate. R, the radius of curvature of the spherical introry and a the index of refraction of the glass

Now, let
$$I(n-1)R^3 = \frac{I}{K}$$
 (then (1) becomes $\Delta = x^2(\tau^* - kr^*)K$ (2)

which is in a convenient form for computation Giving & various values from -- 10 to +30, we obtain the series of curves shown in Figure 5 When A==0 we have a lens with a sharply turned up edge and flat in the center This form is one of the most

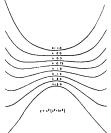


Figure 5: Correcting plate curves

difficult to figure, yet the writers have seen it recommended for amateurs! As k is increased the center rises and the edge is depressed until, when k is unity, edge and center are equally high, and the depressed zone lies 0.707 r from the center. In this form the amount of glass to be abraded from the lens surface is a minimum and it is this figure which we have found most satisfactory for general purposes; it is also the easiest to construct. When k=1.5 we have a correcting plate in which the effect of chromatic aberration is at a minimum. This is the type of correcting plate which we have used for our "thick-mirror Schmidt' cameras, several of which have been con-

structed here. When k=2 the neutral zone is at the edge of the plate and the figure becomes difficult to achieve in practice. In all plates the edge gives some trouble while figuring, because of the flexible nature of the tools used in this work, hence it is hest to make the plates at least 1" larger than the required diameter; the troublesome edge can then he masked out when the camera is assembled It is estimated that the cost of labor in making a correcting plate is reduced at least 50 percent by making a generous allowance for the edge Differentiating (2) and equating to zero,

$$x^{t} = \frac{kr^{t}}{2}.$$

This gives the distance of the neutral zone from the center, and, by substituting this value for x, in (2), we obtain

$$\Delta = \frac{k'r'}{4}K$$

the depth of the curve at this zone. With these two dimensions, (3) and (4), at our disposal the correcting plate may be rapidly roughed out to shape, the depth of the zone being measured with a suitable mirrometer

The angular field, to, of a Schmidt camera is given by the equation

$$\sin \frac{\theta}{2} = \frac{d'}{2j}$$

where d' is the diameter of the plate holder and f is the focal length of the mirror, and, in order to utilize all the light, the diameter, D, of the mirror must be

D=d 4 2d' where d is the diameter of the correcting plate. For ordinary purposes d' should not greatly exceed

The correcting plate is made from planeparallel glass plates free from strike It is very important that the plates be planeparallel, especially for telescopes used for stellar photography If the plates are not plane parallel, glost images, caused by the internal reflections in the lens, will be formed to one side of the brighter stars. (It has been suggested to us that these ghost images night prove useful in stellar photometry.) When the plates are plane-parallel these spurious images fall on the image of the star causing them. For ordinary work a high-grade plate glass, such as Caystalex, may be used, but when high ultra-violet ransmission is desired, glass such as Schott's U.B.K.5 or Vitaglass must be used A satisfactory thickness for the correcting plate is of the order of 1/40 to 1/50 of its diameter.

The plates are best supported, during grinding and polishing, on a circular felt pad which should be shrunk before use, he pad should be a little smaller than the lens. For small lenses the glass is held in position by a metal ring slightly larger in diameter than the disk and projecting above the level of the turntable by an amount sufficient to hold it in place, but not high enough to interfere with the motions of the tool. During grinding and pol ishing the plate should be rotated frequently upon the felt base. In the case of large lenses the plate is best retained on the table by means of sets of vertical spring bronze "fingers" attached to the turntable; at least six such sets should be used.

It will be noted that a certain polishing action is going on, on the rear surface of the plate, during the pollshing stage, due to

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the motion of the plate upon its supporting pad which is difficult to keep free from rouge at this stage. The effect of this is eliminated, after the required figure has been approximated on the front surface, by msking the final corrections on the hack. During grinding no abrasive should reach the back surface of the correcting plate because of the protective gap between the felt and the edge of the lens. (This is the reason for cutting the felt disk smaller than the plate)

The best form of tool we have found for grinding out the zones is constructed as follows Three triants (120-degree sectors of circles) are cut from moderately stiff springhronze sheet in such a manner that the grain of the metal-that is, the direction in which the sheet was rolled -is the same in each. These sectors are then cut into radial "finto the underside of the extremities of which are cemented the grinding facets These facets are cut from unglazed ceramic tile, such as the small size used for bathroom floors. The sectors are then attached to a suitable hub and, if necessary, the fingers may be bent downward and outward, keeping the outer ends parallel to the surface of the plate.

Polishing is done with facets of moderate-ly soft pitch attached to a sponge-ruhher hase about 4" thick, the rubber permitting the tool to conform to the zonal curvature of the correcting plate. Polishing tools with a sponge-ruhher base will be found excellent for working on all optical surfaces where zonal curvature exists.

It will be realized, we think, that all hut the smallest tools are of the ring form For smoothing out irregularities in the curvature of the zones a small common tool, one quarter, or less, of the diameter of the plate may be used. This should be given a long elliptical stroke in the direction of the zone

Schmidt's method of polishing correcting plates was to place them concentrically on the lip of a shallow circular metal pan, the edge of which was ground so that an airtight seal could be made between the glass and the metal. The air was then pumped out of the pan, causing the center of the plate to be depressed; then, by the use of a spherical tool of the correct curvature, the zones were automatically polished to shape. This method is not to be recommended, however, except for mass production, when it becomes the

modus operandi. The figure of the plate may be examined during the grinding stage by dipping it into a solution of ethyl cinnimate and Xylol, mixed in a proportion of 4.1. This forms a smooth coating which has approximately the same index of refraction as the glass. After a little experience it is surprising how readily one can detect small irregularities in the curvature, or the displacement of a zone, by direct visual inspection of the form, using a good straightedge held in contact with the plate as a guide for the eye.

The Chinese mirror effect is sometimes useful in correcting local irregularities, and even in polishing and figuring plates with small curvature. The lens is here supported on suitably shaped pads of semi-cured rub-ber, such as that used for patching automobile inner tubes; the part of the lens thus supported is abraded more rapidly than the unsupported regions.

A number of methods have been worked out here for testing correcting plates, some of which will now be described. The figure of the correcting plate may be readily ex-amined with a knife-edge if one has a telescope sufficiently large to take in the collimated beam from the assembled camera, as shown in Figure 6 at A. Using this method, a point source of light is placed at the focus of the camera, and the knife-edge at the focus of the telescope. The sensitivity of this test is proportional to the square of the ratio of the focal length of the telescope to that of the camera

There a large telescope is not available for testing we can make use of a small one, in conjunction with a pentaprism or an

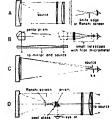


Figure 6: Methods of testing correcting plates for Schmidt types

optical square, as shown at B Here we have a small telescope rigidly set up at right angles to the axis of the camera. The optical square, consisting of two plane mirrors ounted at an angle of 45 degrees, or a pentaprism, is set up in front of the telescope on a base which may be moved across the collimated beam of light. The image of the light source is focused on the intersection of a pair of cross-wires in the focal plane of the telescope. As the pentaprism is moved across the collimated beam the image should remain on the vertical wire; any lateral motion is due to the poor figure of the optical system, vertical motions may be due to ir-

regularities in the motion of the pentaprism. An excellent test for cameras having an aperture f/5, or less, is made by placing the correcting plate directly in contact with the mirror, as at C. The test is made on the axis of the lens, in a manner similar to that used for testing a parabolic mirror in the center of curvature; that is, by measuring the apparent radius of curvature of the various zonès with a knife-edge at the focus. In this case the test is twice as sensitive as that for a parabolic mirror because the light passes twice through the lens. The formula now r; this, when both knifebecomes $\Delta R = \frac{y^2}{2}$

edge and light source move together.

A Ronchi screen placed inside the focus of a Schmidt camera will form a series of fringes on a screen placed at a suitable dis-tance from the focal point, as shown at D. By using an opal or ground-glass screen these fringes may be examined readily. Each fringe should be straight with parallel boundaries, but the presence of zones in the correcting plate distorts these fringes which are interpreted in the usual manner. The familiar Ronchl screen method of testing is excellent, also, for lenses with large aperture ratios, or where the focus is too short for the eye to focus on the equivalent plane An illuminated, small, silvered glass bead serves as an excellent point source of light for testing purposes The illuminating beam

should be concentrated on the face of the bead facing the mirror or lens to be tested. Any stray light which passes the bead should he blocked off by a suitable diaphragm placed behind it-a totally reflecting prism is excellent.

To test a correcting plate made to work in the extreme regions of the spectrum tinfrared or ultra-violet) we can construct a testing mirror of radius R' so that, in equation (1), (n-1)R'=(n'-1)R'

and thus make the tests in visual light which gives an index of refraction of n'.

There are, of course, numerous other methods of testing correcting plates, but those given here are sufficient, we think, for the average reader. It must be remembered that the plates, to begin with, must be plane-parallel, and they must be free from strike In selecting plate glass for correcting plates, sheets should be first tested with a micrometer for uniformity of thickness, and then tested for striae by holding the sheet between a small bright source of light, such as an arc, and a white screen Shadowlike streaks on the screen show the presence of these defects, and their positions can then be marked on the glass with a wax pencil I aless a large plate is required an area large enough for the purpose usually can be selected from relatively cheap glass -- Pasadena, Califor-nia, March, 1939

Till's completes the article by Hendrix and Christie. In reply to a request, the latter states that Schmidt died about four years ago. His only article appeared in Central-Zeitung fur Optik und Mechanik, Bund 52, Heft 2, and in Mitterlungen Hamburg-Bergedorf, Bund 7, No 36, under the title of "Ein lichtstarkes komafries Spiegelsystem

Because of his full occupation with important optical work now in progress at Pasadena, the senior author sincerely regrets that he will not at present find it possible to answer requests for further information.

Crystalex Pittsburgh Plate Glass Co., 2222 Grant Bldg., Pittsburgh, Pa. Schott's glass: Fish-Schurman Corp.,

250 E 43rd St., New York, N Y

Vitaglass The Vitaglass Corp., 220 Fifth Ave New York, N. Y.

The Schmidt camera gives great promise in astronomy, professional and amateur, and there is lots of work for the amateur to do with it. Heretofore a heavy discouragement in undertaking a Schmidt has been the interminable job of excavating the very deep curve of the primary—about ½" deep on a 12½" disk. It is hoped that plans under way as we go to press will nake possible the purchase of pre-roughed-out 121/4" disks.

Last April this column stated that two off-axis mirrors had been made at the Mt. Wilson shops, we learn that two dozen is more nearly the correct number,

Stellafane convention, Sat., July 22

Convention of amateur astronomers, including planetarium show and banquet, at Hayden Planetarium, New York, Aug. 19 and 20. Former day will also be Amateur Astronomers' Day at World's Fair; Professor Shapley will give a talk. A threeweek exhibit of amateurs' work will be held at Hayden Planetarium July 30 to Aug. 20.



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ASTRONOMY

83 #Idlam T Skilling, San Diego State College and Robert S Richardson, Mr. #Idson

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interatives available this new work seems suited to the isolated reader Its senior anitor has long taight astronomy in the Classifier of the college
ther has long taught astronomy in the classroom and knows the corners where the be ginner usually is perplexed -- mainly in the parts having to do with the positions and motions of the heavenly bodies lie set out to make these things as (asily comprehensible in a text as they are in a classroom discussion, and the result is success. The explanations are in simple, homespun words and phrases, and are illustrated with home ly drawings that go to the heart of the chief difficulties. The whole of astronomy from the earth to the known limits of space is systematically covered to the reasonable depth to which the average layman cares to go. Contrary to a widespread misimpression, this book, like all other elementary textbooks of astronomy, does not contain more than I percent of mathematics-the mathematical parts of the science being reserved for special advanced books (579 pages, 512 by 8½ inches, 248 illustrations) \$3.10 postpaid —4 6 I

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LEGAL HIGH-LIGHTS

Patent, Trade Mark, and Related Legal Proceedings That May Have a Direct Effect on Your Business

By ORSON D. MUNN, Litt.B., LL.B., Sc.D.

New York Bar Editor, Scientific American

GLASS HOUSES

PEOPLE who live in glass houses not only should not throw stones but should make sure that they do not infringe a patent recently allowed by the Court of Customs and Patent Appeals.

The inventor of a glass brick applied for a patent on the brick and on a type of building construction using it. The patent was refused by the Patent Office and by the Board of Appeals However, the decision of the Patent Office and the Board of Appeals was reversed by the Court of Customs and Patent Appeals and the patent was allowed The brick in question was a hollow glass block having at least one side thereof fluted or ribbed so as to form prisms. The prisms were so formed that downwardly slanting rays of light such as sunlight, when passing through the brick, were deflected in an upwardly slanting direction on the opposite side of the brick When bricks of this chaiacter were used in constructing a wall the sunlight passing through the wall was deflected onto the ceiling in the inside of the structure Prior to the development of the bruk in question hollow glass bricks had been employed but these bricks were not provided with prisms to cause the deflection of the light upwardly in the manner described above

The Court sponted out that the undrect highling effect caused by the prism arrangment on the new brick was not obtainable by the old type of brick. It was accordingly concluded that since the structure was now and since it produced a new result it constituted invention and that a patent should be granted. In support of its decision the Court stated.

"It seems to us that the concept of cauing defection of hight rays in the manner
which has been described was inventice." To consummate the conception and embody it
in structural form must have required calculations based upon the physical laws re
lating to high, and, finally, experiments to
determine whether the result desired had
been obtained."

AIR SPUN

FACE powder and graphite were held not to be goods of the same descriptive properties in a recent decision of the Court of Customs and Patent Appeals involving the trade mark "Air Spun." A prominent manufacturer of graphite attempted to register the name. "Air Spun" as a trade mark for graphite and the registration was opposed by a commenter manufacturer who used the same name as a trade mark for face prowder. The reasons urged in support of

the opposition were of a rather unusual hearater Thus the consence manufacturer ascerted that graphic was used in lead penits, that the pubble generally associated lead with lead pencils, and that lead, which at one time was employed in face powders and face lottons, was regarded as a harmful ingredient Because of these face is a waarzued that some customers might be led in believe that "Air Spun" face powder controlled that the pencils of the property of were permitted to one and register the trademats. "Air Spun"

The Court rejected this argument, however, and held that any dissage that might result to the cosmetic manufacturer by the reason of the use of the trade mark "Aur reason of the use of the trade mark "Aur "Spin" by the graphite manufacturer was of such a remote and speculative character as not to partly refusal to register the trade mark. It was also pointed out that the good-were of an entirely different class. that they do not look allow, were soft an entirely different class. The trade of the control of the

DISC LAIMER

One of the most unsatisfactory portions of the patent law is that portion dealing with disclaimers. The disclaimer status provides that where a patentic, through madistrience, has claimed more than his invention, he must without unreasonable delay disclaim that which is not his invention in order to reap the benefits of the remainder of his patent.

There has been considerable confusion ato when a disclaimer should be filed and ato the subject matter which should be disclaimed Today it is generally accepted that when a court of last resort has declared some but not all of the claims of a patent to be invalid the patentee has a choice of either acquiescing to the decision of the court and filing a disclaimer or of rejecting the deer sion of the court and relitigating the que tion in a different court in a suit against a different infringer. Where the patentee elects to follow the second alternative he is risking the danger that the second court will agree with the decision of the first court and hold the same claims of the patent to be invalid. in which case the entire patent will be unen forceable because of the failure to file a divclaimer within a reasonable time after the first decision. Thus it will be seen that in every instance where a portion of a patent is declared to be invalid by a court of last reaort a patentee is confronted with the none too-pleasant choice of either emasculating his patent by disclaiming some of the claims thereof or of risking the validity of the en-tire patent by failing to file a disclaimer

within a reasonable time after the first de

them. The dream has emphasized in other control as The dream has emphasized in other congret turking in the doctamer statute. The decision involved a suit for infragment of a parent on a weaking machine. In a prior case several of the claims of the parent had been declared invalid and those claims were checkaimed. In the present case the Court held the remainder of the parent to be unvalid and unacrioreable because the parent was ano involved in the prior Intigation has which the court found to be similar in acopte to one of the claims which the patterner had datediamed.

The Court held that the patentee had elected to disclaim the portion of the patent wheth had previously been declared invalid and having made that election he should have disclaimed all of the claims covering that subject matter. As a result, the suit for patent infringement was dismissed for the rather rethined reason that in fling its disclaiment the patenties had failed to disclaim everything that the should have the claimed. This decision represents one more reason to the contract of t

RUBBER FAN

THE popular fans having rubber blades which waft summer breezes at its without benefit of a protecting guard were involved in a recent suit for patent infringe-

The owner of a patent covering a fan of this character browth surcharping that a some-hal similar fan made by a competitor of the character of the patent. The patent declosed a fan having rubber blades which were accreded in a reason as the patent of the

One of the defenses rused in the out was that the mere need ruther in unking fan blades did not constitute invention. The focurit rejected this contention, pounting out that the patent related to more than the merne of ruther. It usualt the use of a flexi ble material in the making of fan blades and the supporting of the fan blades in such a manner as to give them sufficient rigidity in preserve their weddines while at the same time preserving the inherent resiliency of the material and the resulting adder/character-

In this connection the Court made the following statement

"While the more not rubber in making in his way no invention, the use of a flexible material, which might of course he rubber, in the way the patentee taught how to use it to obtain the desired results by an aching at in his way to the hold to increase its utility as a fan blade without destroying may appreciable way its inherent safety qualities, was what the patent law is designed to protect."

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CONTRIBUTING EDITORS

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NINETY-FIFTH YEAR

ORSON D. MUNN, Editor

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The Reprincepop. Long a Master Key in Scalince, in Fronting to be of
Major Preciding Importance in a Wide Variety of Art and Industries

PROQUIREMENTS of heavy-duty service and quiet operation in electric leconomitive call for a high degree of accuracy in gene cutting. Bence the insupercion device, illustrated on our front cover, wherein three mechanical fingers rapidly check tooth space and tooth contour. The illustration reproduced was made at the Works of the Gearing Division of the Westipshouse Electric & Manufacturing Company at Pittuburgh, Pennylvania.

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SCHEMITIFO AMERICAN, September, 189. Vol. No 181, No. 3, extered at the New York, N Y., Post Office as second cleam matter June 38, 1878, under the act Manes Dr. 1877; additional neight year 1809 Hawre, from Published monthly by Munn & Company, Inc. 3, 1879; additional neight vy york UTC UTC Opportuned 133 by Minns & Company, Inc. 3. Great Estain rights reserved, Subscription price 8400 per year. Ouncide 8400 Provigo 8500. Manuscripts are colonitied at the subscription price 8400 per year. Ouncide 8400 Provigo 8500. Manuscripts are colonitied at the subscription price 8400 per year. Ouncide 8500 Provigo 8500. Manuscripts are colonitied at the subscription price 8400 per year.

50 Years Ago in . . .

SCORMODEC NODERICAN

(Condensed From Issues of September, 1889)

TELESCOPE MIRROR.—"A means whereby concave mirrors of bong forous ney be reachly produced from planet-faved mirrors: in the state herewith. To make such a mirror a pan is employed, preferably nade of cast metal to be extremely radi, and with fainged edges by which it may be boiled by three equidistant bodts to the flanaged end of the tube. This pan is formed with a seat or shoulder, as shown in the sectional view, upon which there is placed a plane mirror, through the axis of which there is drilled.



a small hole adapted to receive a tube, with threaded ends to engage an upper and a lower duck, fitting on the upper and lower faces of the mirror. The hottom of the pan has a central aperture through which is passed a headed and threaded tube engaging the other tube, and the tube passing through the hottom is turned by means of a suitable wrench, to draw the center of the mirror down against its own rigidity, hending it into concave shape."

TUNNEL—"The Iludoso River tunnel, designed to gue passage for railway trans under the wide body of water that separates New York from Jersey City, is agan in process of construction. Vertical shifts were aunk near the shores of the river The one on the west shore is sixty-five feet deep, circular in section, and thirty feet in intensal diameter. The walls himse if are four feet in thickness. From these as starting points to millelism with each diverging shafts to the start of the s

MORTAR.—"A new idea in Germany is the wholesale manufacture of morars of the beat quality, to be sold to small builders and private individuals. Some 2,000,000 bbl. were thus sold last year in Berlin. This obviates the necessity of making the mortar on the ground under unfavorable circumstances and at unnecessary expense."

TUBING.... "Considerable interest was shown at the Brussels exposition in a flexible metallic tubing exhibited . . . formed by wrapping strips of metal spirally around a mandrel. The metal strips were bent over at both sides and a thin, narrow rubber band was

inserted to prevent leakage. The tubes could be bent in any direction, were perfectly tight, and were claimed to possess great resistauce to both internal and external pressures, and to be easily hundled and repaired."

ALUMINUM.—The Putburgh Connected Gazette says: Few persons are aware that an channour-making plant is now in full enterprise of the produced day. It is worth about \$4 per pound, and this is a very large single output when compared with the product of the factories in other parts of the world. The material is used for various purposes. It has taken the place of niker leaf in sign paint ing, and in that particular has proved a great sunccess."

TALKIES.—"At a recent meeting of the French Academy M. Jupman presented a note by M. G. Gueroult, in which it is suggested that by the combined use of a phonograph and an apparatus for instantaneous photography and reproduction of the pictures obtained, it would be possible to reproduce at any future time not only the speech of a person, but also liring before the audience a wide price of the person's, generates and facial expression."

PAST GLORY "In 1880, the total tonnage of the English merhant marine was 18,000,000 tons, and that of the United States 9,000,000—a tonnage four times as large as that of France. American alups numopother nearly 20 percent of the total recursts of the commercial maritime carriage of the world. France and Germany foure in this communication that the state of the properties of the foure in this communication that of the State of the State of the State of the foure in this communication that of the State of

LAMP "A new type of semi-incandrescent lamp", consists of two horizontal rods of copper, set in line with each other, but separated by a pages of about 3/6 of an use. A thin third carbon rod is set vertically, and rests upon the ends of the copper rod, forming a bridge across. The current passes through the copper rods and through the point of the carbon rod, which is thereby rendered health and the carbon rod, which is thereby rendered brilliantly incandecesent."

GIIN.—"The great 1206 inch De Bange gun excites much attention at the Pans rathbuton. It was tested on the trial ground at Galass on May 7, 8, and 9 last . The greatest range was a trifle short of twelve miles. A war also capable of carrying and discharging these weapons might be three miles out in the ocean off shore at Coney Island, and throw projectiles into the citres of New York and Brooklyn. Our war department should begin to think about obtaining some of these arms."

ELECTRICITY—"According to reliable reports, there are at present 3351 isolated electric lighting plants and central stations in the United States alone, operating 192,500 are and 1,925,000 incandescent lights each night."

AND NOW FOR THE FUTURE

Insanity at the Wheel-What Psychologists are Doing for Highway Safety, by Andrew R. Boone.

IFungus Threatens Poor Man's Food-Fruit—the Banans, by Charles Morrow Wilson.

Manganese from Cuba—Hope of Our Steel Industry Ct., y Richard B. Clerkson.

The Real Low-Down on High Blood Pressure, by T. Swann Harding.

Biggest Explosion in Atomic History—Two Elements for One, by Jean Harrington.

OUR POINT OF VIEW

Oily Outlook

PETROLEUM, black gold of the oil more ways than one has made possible our highly developed automotive age, holds forth promises of even greater marvels in years to rome. Given a quantity of petroleum, the modern researchement produces an awe-inspiring variety of materials which, in one way or another, can militioned, even change the mode of, our daily lives And this to does with what, in the future, will be considered to be a meager knowledge of his subject.

Meager though present-day knowledge may be, developments in the field of petroleum research make it possible for the technologist with a flair for prophesy to give us a well-founded glimpse of what the future holds in store. Thus, Dr. A. E. Dunstan, British petroleum technologist, did not stretch facts beyond possibilities when he visualized the petroleum home of the future where even the food served will, in part at least, be derived from petroleum. Briefly described, Dr. Dunstan's dream home will have a roof of petrolenm-base tile and walls of synthetic glass or hollow brick, while doors, partitions, windows, and even furniture will be fashioned of some form or another of petroleum-extracted plastics. Decorative effects will be obtained with similar plastics, aided by brilliant or subtle colorings skilfully obtained from through the use of petroleum dyes.

The people who live in these petroleum-created homes will even wear clothes whose origin will lie in petroleum. Fibers made from a petroleum base will be woven into fabrics that, in turn, will be colored with dyes from the same source.

Synthetic food from potroleum will constitute at least a part of man's det. Dr. Dunstan believes, and backs up this thought with a reference to the fatty acids that can now be extracted from petroleum. These substances could very likely be combined with other petroleum derivatives to form foods that would equal in nutritive value the animal and vegetable fats of today.

Whence will come the vast supplies the program? Alarmsts would have it that our petroleum reserves will be exhausted shortly. But improved methods of reclaiming oil from Mother Earth, new fields being explored, more efficient utilization of petroleum, are all pushing further and further into the future the time when the point of exhaustion will be reached. In the meantime, it is pleasant and inspiring to let the mind wander through new fields to a region where today's home will be yesterday's potential crankcase filling.—d. P. P.

Hypergeometry and Hyperperplexity

OME months ago-as long ago as March, in fact this journal published an article entitled "Visualizing Hyperspace," in which was discussed a fourth dimension of space and a method of visualizing exactly what this kind of space would look like if there were such a thing. From time to time since then the editors have received inquiries from puzzled readers who appear to be confused about a variety of questions suggested by this article. Is not time the fourth dimension? How do the mathematicians know that there are more than the three common dimensions with which we are all daily familiar? How many more dimensions are there and, anyway, aren't a good many of the mathematicians just a bit "teched"?

First, icgarding time as the fourth dimension: True, time does figure in the so-called "space-time continuum," but not as an extra dimension of space.

Next, how do they know there are extra dimensions of space? They don't! They play with them, however, just as if they did exist. All the mathematician does is to take the algebraic formulas of analytic geometry whech the has any piech to three-dimensional space and go on developing them in the same way for added dimensional. It is a game but the matter ends there—that is, so far as they know, for it is of course dogmatic to assert positively that there are no extra space dimensions. All we can assert is that, if there are, man has never rune across any real ones.

The mathematican is a whimsued fellow who thoroughly enjoys deliberately creating a make-believe and then proceeding to show what would be the case of it were true. He does this sumply because it is such fun. His brain is active and can't help playing these little games. And, at that, there is no crime in extending his logical processes out mathematical transfer of the companion of the sident throughout—that is all science

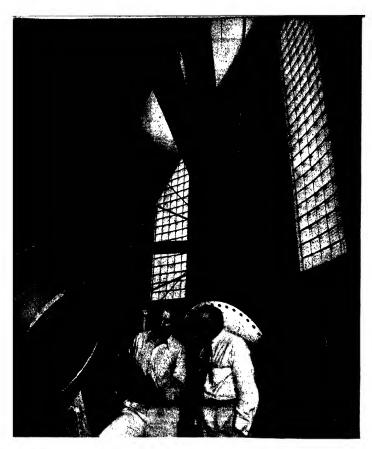
What probably confuses the puzzled non-mathematician is the fact that the mathematician uses for his excursions into the imaginary the same word he uses in connection with something he and all the rest of us knows to exist; that is, "dimensions" If he would call them something else the confusion would promptly end for most of us.—A. G. I.

Trees

TO say that all the lumber cut in the United States during the past 135 years would make a solid cube a mile on each dimension would not impress many people. We just don't visualize the enormity of such a cube. In terms of board-feet, however, the quantity shows up clearer and we begin to realize the inroads we have made on our tumber resources A cubic mile of lumber would total considerably more than 1700 billion board-feet. Yet this is only a fraction of the drain on our forests, for the vastly increased demands for pulpwood-for paper, rayon, and related products-has denuded many thousands of once heavily forested acres And the continual process of cutting firewood and of clearing wooded areas for farming, as old farm soil wears out and is abandoned, is taking its toll.

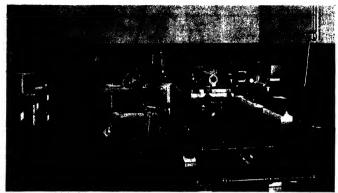
Conservationists are now, therefore, cheered by the news that farmers have more than doubled their tree-planting since 1935. The Forest Service of the Department of Agriculture reports distribution in 1938 of over 55 million tree seedlings and transplants as compared with a distribution of only a little over 26 million in 1935. The law providing for such distribution by the Federal Government in co-operation with state governments-the Clarke-McNary Law --- is not so new that it would provide explanation for this spurt in planting. It dates from 1924. The indication is that some other factor is involved, and we'd like to feel that it is a nascent consciousness of our sins of the past and of the great value of trees in our national economy-trees standing alone or in woods, forests, or wind-breaks.

The timber companies and the paper mills have that consciousness and are doing their share by reforesting as fast as they cut. New farm planting, if the dea continues to grow, will round out the cycle and assure maintenance of a continuing supply of wood for all purposes. New growth will be slow in maturing, of course, but we certainly must have reached the point where the patience should rule—after our years not of impatience to grab, before omeoneneelse did, the golden profits from Nature's bounty of trees.—F. D. M.



WITHIN THE HOUSING OF A GIANT ATOM SMASHER

TO "smash" atoms they must be bombarded with high-speed particles. One way to give particles high speed is with the cyclotron, while another is by means of an electrostatic machine. Better results are had if this machine is aperated in an atmosphere of compressed gas, and this has led to the installation of atom smashing equipment inside very large steel tanks to permit control of this factor. The photograph shows the exterior of the huge container of the Van de Craff generator now under construction at the Carnegie Institution of Washington, inside its Insulex glass block housing.



ustrations courtesy Technology Resists

A spectrograph of the kind used in measuring small amounts of impurities in metals, as in manufacturers' laboratories

Eyes That See Through Atoms.

(In Two Parts-Part One)

THERE exist a few scientific instruments which, though they have contributed directly to the establishment of no vast new factories, and are never sold over the counter, are of incalculable value to mankind. One of the most powerful and useful of these instruments is the spectroscope; indeed, Henry Norris Russell has called the spectroscope the Master Key of Science. It appears to be true that with this talented instrument scientists have succeeded in unlocking more secrets of nature than with any other single device. Though comparatively simple in its structure and operation, the spectroscope gives answers to an incredibly wide variety of questions merely by dissecting a beam of light and separating this into its component colors.

Is life possible on Mars? Ask the spectroscope. Is a certain painter's ill-ness caused by lead poisoning? The spectroscope can tell. How much does the core of a helium atom weigh, and how much that distant star? Does this greenhouse contain the correct amount of carbon dioxide to support plant life? Of what is the tail of a comet made? How many electrons are there in an iron

*Copyright 1839, by the Author, From the book "Atoms in Action: The World of Creative Physics," by George Russell Harrison. (Shortly to be pubThe Spectroscope, Long a Master Key in Science, is Proving to be of Major Practical Importance in a Wide Variety of Arts and Industries

By GEORGE RUSSELL HARRISON, Ph.D.

Professor of Experimental Physics and Director of this Research
Laboratory of Physics at the Massechustal Emilitate of Technology

atom? Is this the sweater of the burglar who crawled through that broken window? How hot is the Sun? Thousands of such questions are being asked from time to time, and are being answered correctly with the aid of the spectroscope.

ANY atom or molecule will emit light if it be struck a hard atomic blow, and all light originates from atoms which have thus been atmulated by heat or electricity. Since any material object—a starp, a drop of blood, a speck of putty object can be induced to emit light by heating it until it becomes an ineandesent approach of atoms, any material structure of the composed of atoms, any material structure of the composed of atoms, any material when the composed of atoms, any material with the composed of atoms, any material with the induced to emit light by heating it until it becomes an ineandesecret vapor. The light which is thus emitted carries inevitably in itself many secrets concerning the atoms from which it originated. It is the function of the spectroscope to analyze this light, and thus lay bare these secrets for the eye of science to read.

The chemist finds that a tiny pinch of salt needs more than a bathtub full of water in which to hide from the ferreting eye of the spectroscope, and he uses this instrument regularly to detect and measure minute traces of impurities in the materials with which he works. So bright is the light which the atoms in a small speck of metal can emit, that a piece of brass the size of a pinhead will serve for a complete determination of the presence or absence of 70 of the chemical elements. and none will be overlooked which is present in an amount as great as one millionth part of the whole. In fact, at least ten of the chemical elements were originally discovered with the spectroscope.

Atoms which are to be studied with a spectroscope need not be anywhere near it, for the light which they emit can travel a billion miles across space and still deliver up its secrets when captured

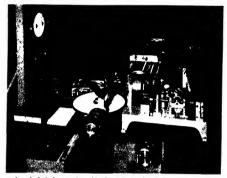
and analyzed. The astronomer is thus enabled to analyze the materials of distant stars, and has learned that even the farthest visible nebula is composed of the same atoms that we know on earthdust similar to dust across the vast stretches of the cosmos. More than three fourths of the discoveries of modern astronomy have been made with the spectroscope, and no large telescope is considered complete without one to sort out the light it gathers. Nor is the spectroscope merely an analytical tool, for with it stars and nehulae can be weighed, their temperatures taken, their speeds through space measured, and the courses charted of their lives and deaths.

To the biologist and physician also the spectroscope is invaluable, for with it such complicated molecules as those of vitamins and hormones can be studied. and metallic poisons can be detected in the blood long before they accumulate in amounts sufficient to be harmful. If the human body is analyzed down to its constituent elements, almost every kind of atom is found, but many are present in extremely small amounts. Which are essential to life and which are merely incidental? For example, little copper is found; too much copper is poisonous; yet some copper must be present if life is to continue. How much copper is too much, the spectroscope is helping the physician to determine. The same question must be answered for numerous other kinds of atoms.

other kinds of atoms. Drugs also can be studied with the spectroscope. In cases where cocaine possoning is suspected, a few drops of fluid taken from the spine of the patient can be diluted and the cocaine content can immediately be determined from its light absorption. To draw enough fluid to analyze chemically might harm the nations.

ENGINEERS find the spectroscope useful also. With it they can look made the cylinder of an engine while this is in operation, and study the burning and explosion of gases and the propagation of pressure in the cylinder. A plug of metal is cut from the top of the engine and a thick window of clear fixed quartz is inserted in its place. Through this window comes enough light to enable the spectroscope to establish the temperature of the flame at any metant, and to give analyses of the composition and rate of burning of the fuel.

Even in crime detection the spectroscope is useful, and it has had its day in court in a number of lawsuits. In one case, gasoline which exploded in a sewer was traced to one of a dozen filling stations in the neighborhood from which it might have leaked, by using the spectroscope to show that the gasoline found remaining in the sewer



A newly devised automatic machine for measuring the wavelengths of the light producing spectrum lines, directly from the positions of the lines on a spectregram. The spectrogram is clamped on the carriage in rear, the projection affectoscope above it throwing the spectrum on a screen in the center of which is a all which admits the light to an electron multiplier. The carriage is moved by the lead-acress above, and the dial geared to this reads in nearterm

absorbed light identically with the brand sold hy the station. The G-men in their government laboratories use the spectroscope regularly, as do workers in the various state criminological laboratories.

The spectroscope is thus at once, a powerful tool for analyzing matter; a super-telescope, and a super-microscope; a super-specdometer, thermomerect, tape-measure, and clock. In each role it exceeds in range and power the more common forms of these devices. This it can do because it attacks fundamentals; it studies the world and the heavens in terms of the very atoms of which they are made, and these atoms in terms of the energy which is their very life.

The foundations of spectroscopy were laid by a 24-year-old boy. One day in 1666 a young student, later to win fame as Sir Isaac Newton, threw the first purposefully produced indoor "raın how" on the wall of his bedroom. Newton thrust a prism into a beam of light which was shining through a round hole in his landlady's windowshade, and saw that the prism split the white light up into a bright spectrum of colors. By so doing he came breathtakingly close to inventing a spectroscope. If the sunlight had entered through a crack in the shade instead of through a hole, and if Newton had turned his prism so that its base was parallel to this crack, and had inserted a pair of lenses into the beam, he might have noticed dark streaks or lines running across some of the colors on the wall. More than a century elapsed, however, before Joseph von Fraunhofer designed a spectroscope which would separate light into its ultimate purity of color, and observed these dark lines in the spectrum.

Despite its tremendous analytical powers, a spectroscope is really a simple instrument, and it has no moving parts to wear out. Light to be analyzed is sent into it through a narrow slit, and then passes through a prism or similar device which separates the different waves of light in accordance with their lengths. Waves of each particular length are sent in a particular direction, where they can be observed with a small telescope. The lenses in this telescope serve to heap similar waves neatly together in one pile, where they appear as a line of colored light, an image of the spectroscope slit in light of utmost purity.

THE great power of the spectroscope arises from the fact that under sufficient provocation all atoms and molecules emit light, and each of the kinds of atonis which make up our earth-iron and hydrogen and sodium and more than fourscore others emits light of certain wavelengths and those only. Since light waves are identical with ultra-short radio waves, under proper stimulation every atom becomes in fact a tiny short-wave radio transmitting station. When a radio set is tuned to a certain wavelength a peak of sound intensity is heard if some station is broadcasting on that wavelength; a

spectrum line is the peak of light seen at a certain wavelength because an atom is broadcasting on that wavelength. The millions of atoms in a finner or electric are broadcast on hundreds of frequencies at the same time, but the spectroscope can be tuned to all these wavelengths simultaneously, sorting them out so that all can be observed together without mutual interference.

Though the waves which the atoms emit bring no purposeful message, they tell much, and by literally reading

1,000,000 separate spectrum lines have been distinguished all told, and most of these have been distinguished all told, and most of these have been identified as caused by the light which comes from one or another of the various kinds of atoms and molecules of which matter is composed. Since one or two carefully measured lines one or two carefully measured lines will serve to identify the atom which emitted them, it thus becomes almost impossible for an atom to mask its identify it is light can be sent through a spectroscope.

The patterning of lines in a spectrum



A large diffraction-grating spectrograph. Light which comes through a slit at the far side of the circular track, just to the left of the center, is spread by a diffraction grating in the black box at the right sround the circle as a spectrum. Photographic plates are placed in proper positions to record the lines

between the lines (to seven figures, in fact) the physicist has been able to deduce many facts about the atomic world from the broadcasts which originate there. Most important is the identification of sending atoms merely by noting the wavelengths on which broadcasting is being done. Just as an experienced radio listener knows that he is hearing station WZZZ when he turns the radio dial to 422 meters and hears any sort of noise, merely because WZZZ is the only station which broadcasts on that wavelength which his set will pick up, so a spectroscopist knows that he is looking at light from sodium atoms when he sees the familiar yellow light of the sodium flame, because sodium atoms broadcast on the yellow wavelength 0.5893 micro-meters. (This is usually written by the spectroscopist 5893 angstroms. Ten billion angstroms is one

The spectroscopist can be even surer of his station identification than the radio listener can, for each atom broadcasts not on one wavelength alone, but on a whole group of wavelengths. Iron atoms, for example, when made sufficiently hot are found to produce more than 20,000 spectrum lines. More than

s a language which the spectroscopist has gradually learned to read clearly. As the series of irregular black marks on this page conveys certain ideas to a reader, so the unevenly spaced lines in a spectrum convey to the scientust flashes of information—here is iron, here arenic, here are lines of copper and lead. Some of the lines are brighter than others, so the light can even be made to tell how many atoms of each kind are broadcasting—here is a great deal of iron, here a little arsenic, here too much copper in this lead.

Since the spectroscope arranges the spectrum lines in order of wave-length it is not necessary that they be seen in color, and they can therefore be photographed and later identified from their positions on the resulting spectogram. This method of observing spectra is now commonly used, both because the records thus produced can be studied at leisure, and because many spectrum lines are found in the ultra-violet and infra-red regions where they cannot be seen but can be photographed with ease. When a camera is thus used in combination with a spectroscope the resulting instrument is called a spectrograph.

Most small spectrographs contain a

prism to split the light which passes them into its constituent wavelengths, but large instruments use a more powerful device, a scientific light-sieve called a diffraction grating. This is usually a highly polished mirror on which as many as 200,000 sharp, parallel scratches have been accurately ruled with the point of a diamond. These narrow scratches, when evenly spaced 20 or 30 thousand to the inch and accurately placed to within a thousandth of the thickness of a hair, sort the light waves into spectrum lines without the use of auxiliary lenses. Prisms must be made of transparent material: glass serves for visible light, but quartz is needed for ultra-violet and rock salt or some similar material for infra-red light. A diffraction grating ruled on a mirror has the advantage that it can be used with waves of any length, within reason.

LARGE diffraction-grating spectro-A graph requires a vast, vibration free room to house it, and can throw light into a spectrum stretching a hundred feet around a huge circle. Such instruments are giants compared with the most common spectroscopes, small brass tubes on tripody familiar in elementary science laboratories. The positions of spectrum hues can be determined to within 1/25,000 of an inch, and when such precision is attained the length of the light waves is determined to one part in 3,000,000. Since the light waves are themselves only about 1/50,000 of an inch long, their lengths can thus be found to within a few trillionths of an inch-a billionth of the thickness of a

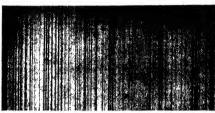
When a spectrograph is used to determine which kinds of atoms are present in a given sample of material, the sample is vaporized and a discharge of electric current is sent through it. The simplest method of accomplishing this is to strike an electric arc between two pieces of very pure graphite, and insert into this arc the speck of nietal or clot of blood which is to be analyzed, so that it is burned to nothingness. This burning tears the molecules of the material apart, separates them into their constituent atoms, and pounds each atom so hard with a deluge of electrons and other atoms that it emits the light which reveals its identity.

Suppose that a manufacturer of watches finds that a competitor is using a new hairspring of remarkable quality. This spring must be duplicated or improved on at any cost, but what can it contain that confers on its student her new temper and elasticity which are so desirable? If a chemist is to analyze the spring by ordinary means he must buy several dozen watches, extract their tiny springs, and then guess which substances are most likely to be involved, so as to select the proper

chemical reactions to carry out. He must dissolve and mix and scrape and weigh his materials with the greatest of care, for one single atom of a new alloying material to every 100,000 atoms of the watch-spring material may be responsible for conferring the high quality, and these are easily lost in a tiny sample.

How much more directly can the problem be attacked with a spectrograph! Now the chemist need merely strike an electric arc between two pieces of graphite, insert a small section of the extra-pure, 1000-proof gold which is the basis of the currencies of many countries is found to contain much atomic dirt under this revealing eye which sethrough atoms, and if the average is like the samples which have thus far been measured, dross of various kinds totalling more than \$1,000,000 in supposed value exists in the gold of the world.

An entire freight tran filled with pig-iron can be tested in a few hours by a spectroscopist dragging electric wires behind him as be proceeds from car to car, and carrying a small spectroscope



A typical section of a spectrogram taken by means of a large diffraction grating. This example shows the characteristic spectrum lines as emitted by iron

spring into the flame, and let the flash of light which results enter his mstrument and be recorded. When the plate is developed it shows hundreds of spectrum lines, and from these can be selected those which are known to arise from each kind of atom. It is but the work of a few moments to identify lines of iron, copper, chromium, nickel-all common in springs of one sort or another. But here are some lines which belong to hafnium-there must be hafnium in the spring! That no metallurgist or clicnist would have guessed that hafnium would improve a hairspring is of no consequence, for the hafnium is there, it is the only new element present. and the springs are strong and supple.

ALMOST any material can be burned in the bilistering 9000 degrees, Fahnett, of an electric are, and if a material can be burned its metallic constituents can be determined with the spectrograph, whether it be a sample of blood from a patient suffering from lead poisoning, a drop of condensed milk thought to consum more than one part of corper in 3,000,000 parts of order of the suffering condenses of the suffering condenses of the suffering collected within kinn pater. Since it is not necessary to know in advance what kinned of atoms are being looked for, 70 kinds of atoms are being looked for, 70 kinds of atoms can be tested for in one sensestion.

No metal has ever been made so pure that the spectroscope could not find impurities in it. Even the superfine, in his hand. Opening a car door he clips a wire to a sample pig, strikes an electric are between this and a harof pure ron he carries, and observes the light in the spectroscope. If certain inpurity lines are brighter than a standard which his instrument shows, that pig contains too much inpure metal, and he passes to another. By properly selecting samples at random the whole trainload of iron can be tested without bothering to unload it.

Amounts of metal so small as to be difficult to detect chemically are often of great biological importance. Why, for example, do the livers of scallops concentrate cadmium?

A little copper is good for the digestion, but too much is not. In areas where many cranberries are grown, sprays have for years been used to kill pests, and the government at one time feared that the soil might have become so saturated with copper from these sprays that the cranberries might be absorbing more copper than would be good for the consumers. So cranberries, cranberry jelly, cranberry juice, dirt from cranberry bogs, and cranberry stems and leaves were all separately consumed in electric arcs and forced to reveal their conner content to the discerning spectrograph. Fortunately the instrument announced that all was well.

Very small amounts of lead or arsenic can do great damage to the human body, and lead poisoning is one of the greatest hazards of industry. Lead fumes are

found in some mines, and in storage hattery and paint factories. Unless some care is taken to protect workers in these industries the amount of lead in their bodies may slowly rise past the danger point, and once this point is passed the resulting diseases are very difficult to cure. It is therefore important to keep a constant check on the lead content of the blood of such workers. By placing a few drops of blood from a worker in a tiny carbon cup and striking an electric arc to this cup, the blood can be vaporized almost instantly, and any lead atoms present will emit their characteristic light, which can be identified with a spectrograph This light being recorded on the photographic plate, a series of samples of blood containing no lead, but with varying known amounts of lead added to each sample, is burned and has its spectra recorded. The spectroscopist matches the intensities of the lead lines in the worker's blood with those in some of the samples whose lead content is known, and thus can measure amounts as little as one atom of lead to 1,000,000 molecules of blood. If a person be allowed to sleen for one night in a freshly painted room a definite, though harmless, increase in the lead content of his blood can often be observed with the spectrograph. Nor is this sensitivity confined only to lead, for any one of the nearly 70 other sensitive chemical elements can be determined as readily

That two or three parts of aluminum or or lead can be detected readily in or lead can be detected readily in 10,000,000 parts of lobster or condensed milk may seem unimportant, since such concentrations are below the toxic limits considered dangerous to health. Yet, obviously, tests on the rapidity with which the internal coating of a can dissolves in foods stored within it can be made easily and quickly when such sensitive methods of detection are swallable.

Chocolate and chewing gum manufacturers use spectroscopic analysis of maure that the lead content of their products is below the limit set by pure food laws. Have the areasic and lead been properly removed from sprayed foods before canning? Is beer kept in cans dissolving anything more from the container than it would if kept in bottles? The spectroscope gives an easy, sure, and quick means of deciding,

So we find paper maintacturers who want to discover the source of tiny black specks in their spotless while product, producers of bakery equipment who wonder if their new coating compound for pans will contaminate the dough, park-plug manufacturers who wish to study the effect of minute amounts of alkali metals in improving sparking, all finding the apertoscope helpful.

. (To be concluded)

FIVE COMPANIES PRESENT: SAFETY

Superior Safety Glass... Four Times Safety Factor, Five Times Elasticity of Old Product... No Fogging... No Break-away... No Splinters

AMERICA'S 25,000,000 comfort-conscious motorists have grown safetyminded to such a degree that they are quick to acclaim the development by science and industry of some noteworthy contribution that makes the automobile a safer mode of transportation.

Such a contribution is the new, lustrous, high-test safety plate glass which graces many of the sleek 1939 model

automobiles, adding greater safety and vasibility. The glass has four times the safety factor and five times the elasticity of the old product. It was developed during six years of intensive laboratory experiments by five large industrial firms at an aggregate expenditure of more than \$6,000,000.

Sharing in the development of the product, which has been made available at no increased cost, are E. I. du Pont de Nemours & Co., Inc., Libbey - Owens - Ford Glass Co., Monsanto Chemical Co., Pittsburgh Plate Glass Co., and the Carbide

sun. This enables the glass to retain its high visibility. Resilience of the glass is unaffected by extreme ranges of temperature, making it equally safe in summer and winter. It is easy to cut, facilitating replacements for damaged areas.

Statistics show that more than half of the injuries resulting from automobile accidents in the past have been



At right: Two research men stretch a plece of the glass "sandwich" filler to show its resilience. Above: Girl work-ers make the "sandwiches" by inserting a sheet of the polyvinyl acetal resin between sheets of polished plate glass



and Carbon Chemicals Corporation.
In perfecting the new glass, the
laboratory technicians made as product
that defies deterioration and discoloration, either from seepage of moisture
and air into the "sandwich" plastic
filler between the two sheets of plate
glass, or from the actinic rays of the

attributed to flying glass. This danger is further lessened by the new glass, because if it is broken by the impact of an object, the pieces adhere firmly to the plastic "sandwich" filler and do not fly about the car.

Because of its resiliency.

the new glass supplies a cushioning effect when a body or head is thrown violently against it. There is greatly lessened danger of a fracture of head or limb as the glass give readily and absorbs part of the shock. To test this feature, one of the research laboratories employed a professional stunt man to batter his beld head against



Repeated hammering on the new glass merely powders the surface

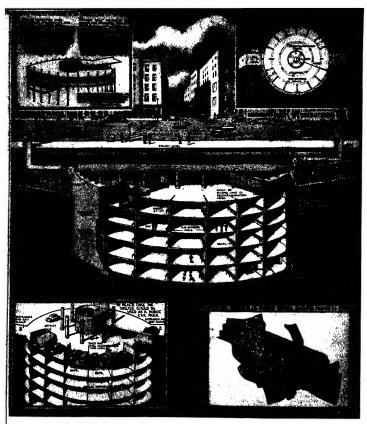
a plate of the safety glass. In repeated demonstrations, charging into the glass like a football player making a tackle, the man cracked the glass with his head but received no injury

DESPITE its greater resistance to the breakage from sudden impact, the breakage from sudden impact, the probability" of the new glass enables a passenger, trapped m a car equipped with it, to push the glass out of its frame as a means of scape When the glass is broken up by hammering it can be rolled up like a rug without the particles of shattered glass pulling away from the plaste filler.

The plastic, or "sandwich" filler, is the principal factor in the success of the new glass. Although it is made under several trade names, the plastic has one chemical common denominator polyvinyl acetal resin.

In the ten years that followed the first general use of lamineted safety glass, alaboratory technicians have bent every effort to produce the features which are dominant in the new high-test glass. Vinyl plastic is resistant to moisture, which makes is unnecessary to seal the edges. It will not separate from the glass under impact or when the glass is cracked or broken. Replacement areas are cut by seoring and cracking, drawing the glass away from the plastic, and cutture, it with a razor blade.

The new plastic may be produced either by calendering or extruding. The first method involves rolling and pressing out sheets of plastic, and the second forces the plastic at a doughly consistency through a narrow orifice. The resulting sheeting is quickly cooled.

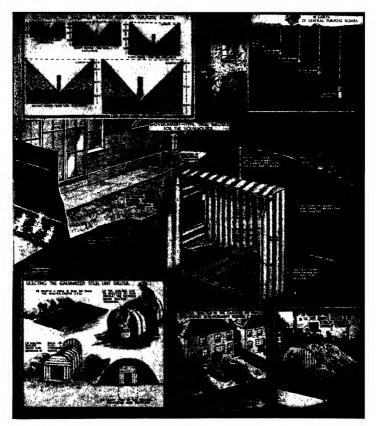


Bombing Raids Will Find London Prepared

NoT long ago a writer facetously pointed out the irony NoT long ago a writer facetously pointed out the irony in large sections of the world. Primitive man (he reminded us) lived in caves or holes in the ground, but as he achieved crilitation he came out into the air and sunshine. Down through the ages he progressed, built great cities, mastered the secrets of the world about him. He rose to new and greater triumphs until he finally left the dirt and took to the air, glorously happy in his goddlied genius. And then the cycle suddenly begins again. One of man's latest and most spectacular achievements turned, like Frankenstein's monster,

upon its maker and sent him scuttling back to holes in the ground—modern, civilized troglodytes.

The analogy was interesting, the irony real, but the aforesaid writer intended only to provide a bit of humor to offset the seriousness of air hombing dangers. They are serious, indeed, as many millions of Englishmen will testify. London knows something of what may happen when and if enemy bombers fly over the city. Shanghai and Nanking, Madrid and Barcelona—current and recent brutalities—have provided the object lessons. But they are not enough, and London surmises many things more, takes no chances, provides against



many contingencies. Now London stands determined, methodically preparing against the day which the world hopes will not come. Intensively, the city and the surrounding country make their plans for lessening the danger and destruction of an air raid, having made up their collective mind to go back to earth, literally, should bombing planes arrive.

A bombing raid over London would be no half-hearted fair. There is no doubt that the enemies of Britain would stage a monster raid—or series of raids—in the hope of gaining a smashing victory. However this night affect the population, psychologically, and how great the destruction of property might be are besided the point at the moment; whether any great number of civilians might be killed would depend upon how well bomb-proof shelters are distributed through out the areas involved. Plans have been made, considered, and discarded and other plans made up for large underground shelters that will house the multitudes during raids. On the opposite page is one suggested design of a structure which would be very effective, and it has the added merat of being useful during peacetime as a public car-parking space. Conceivably some of the large shelters may be built to this design or some modification of it. On this page are shown several views of one of the back yard shelters for residences. There are a number of variations of this type, protecting only against concussion and flying debris, being installed all over the threatened area. The inserts on the two pages show various details. This drawing is published through the courtesy of The Illustrated London News.

RIVER MODELS OUTWIT NATURE

NATURE poses no challenge more baffling to man than the one offered by flowing water. The enigma of flowing water is made the more challenging because it is presented before man's very eyes. Man can observe water in motion; he can photograph it and record certain of its physical dimensions; but he cannot explain what he sees and records. The road to geometry is indeed a royal boulevard compared to the byways which must be traversed by the hydraulic engineer

The sad fact of man's mability to rationalize the phenomena of flowing water has not obviated the equally sad fact that often he must do something about those phenomena. Lands must

be made safe from flood. rivers must be made navigable, erosion must be checked, and so on. There are problems to be solved, whether or not the means for rational solution are at hand. Furthermore, the hydraulic engineer has not the advantage of being able to bury his mistakes. If the levee is built too low, the flood comes with redoubled fury; if the dike is built in the wrong place, the river steamer and its cargo end up on a sandbar. Having made it difficult to win. Nature nevertheless has not neglected to make it costly to lose.

When rational solution fails, man resorts to solution-by-trial. He calculates

things to the best of his ability, tempers, and is calculations with judgment, adds a silberal factor of safety-ignorance, build has structures, and hopes for the best. If calculations, judgment, and luck are agood, the structures stand and serve their purpose; if luck or other factors are bad, there is a flood or an unnavigable channel or a dangerous erosion. Occordon bad the process of solution-by-trial obviously is expensive—expensive in the way of a disaster at worst, and expensive in the way of a disaster at worst, and expensive in the way of over-design at best.

Since the solution of hydraulic problems must, in the main, be by the method of trial (and error), it is idle to think of such problems in terms of absolute economy; rather, the hydraulic engineer thinks in terms of relative economy. And it must early have occurred to him to Miniatures of Rivers, Harbors, Dam Projects Solve Flood and Flow Problems... Considerable Design Ingenuity Involved in Model Making

By PAUL W. THOMPSON

First Lieutenant, C E, and Director, The U S Waterways Experiment Station

wonder whether the trial-and-error process might not be more economically accomplished if applied not directly to the waterway in question, but rather to a small-scale replica thereof. When that thought occurred to some early hydraulic engineer (could it have been during the conception of the Roman



A model of the river through Johnstown, Pennsylvania, by means of which a very serious flood problem was solved

aqueducts?) the now-flourishing science of analyses of hydraulic problems by means of small-scale models was born.

Today, few important projects involving the flow of water are undertaken without benefit of model-analyses. That statement is a paraphrase of the comments with which the English scientist, Sir Osborne Reynolds, concluded the account of his pioneer model study of conditions in the River Mersey in 1885. Sir Osborne's observations had convinced him that it would be "madness" not to take advantage of the small-scale model in designing any important project. The hydraulic world by no means flocked to get aboard the Reynolds bandwagon; but now, 50 years later, that world has practically accepted the Reynolds point of view. By the turn of the century, the German hydraulic engineers were model-minded; whereas, in America, the U. S. Waterways Experiment Station—now the largest of the world's hydraulic laboratories — has been in active operation for more than nine years.

What, then, is the small-scale modelthis tool which, while not eliminating

the necessity for solution of hydraulic problems by the method of trial, nevertheless enables the hydraulic engineer to do his trying and erring at relatively little expense? Briefly, the smallscale model, as utilized in hydraulic engineering, is a replica which acts like its prototype. The verb deserves the emphasis, for the essence of model-analysis is action. There is a technical expression covering the thought: dynamical similitude.

THE purusit of dynamical similitude permits of no side diversions. It demands compromises and apparent contradictions. Thus, in getting a model to act like its

prototype, in grandele, was minerally prototype, in frequently in necessary to take steps which presided for a lade and the steps which presided for a lade and the steps of t

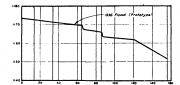
This distortion in the model' physical dimensions and appearance is a necessary evil, force on the experimenter by such hard facts as limitations of available materials; conflict of various forces; necessity for depths not less than certain minims; necessity for conomy; and other considerations. The model, in fact, represents a series of compromises,

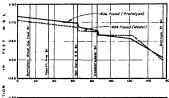
an assembly of components in which one distortion compensates for another. The fact that the experimenter must distort, say, his model bed material (by using some material, such as crushed coal, which is available but is too heavy) makes it necessary for him to distort his velocities (by making them higher than they should be); and the fact that he distorts his velocities makes it necessary for him to distort his model roughness. The thought may be conveniently expressed by stating that the model-as-itshould-be is quite a different article from the model-as-1t-18.

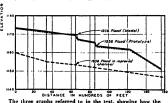
Consider again the model of the Ohio River, mentioned before Rational analysis does not even suffice to make that model act like the Ohio River, (In fact, were rational analysis equal to that task, probably it also would be equal to the task of solving the prototype problem and thereby the model study would be unnecessary) How, then, is it established that the model does act like the Ohio River? The simplest way to answer that pertinent question is to let it answer itself by means of an example.

One of America's critical flood problems has existed along the Conemaugh River

and its tributaries at Johnstown, Pennsylvania. The great flood of March, 1936, was followed by a project aiming to increase very materally the capacity of the Johnstown channels. The project moviews deepening the present channels, widening them, and, to some extent, realigning them. Details have been resolved by means of the small-scale model shown in an accompanying photograph. All horizontal dimensions on this model are 1/200 and all vertical dimensions are 1/80 of the corresponding prototype dimensions. Thus, the model-river is







The three graphs referred to in the text, showing how the model reproduced the 1936 Johnstown flood and the height which the same flood would reach in an improved channel

relatively deep and steep. Meanwhile, the areas enclosed by tin walls represent city blocks. Certainly, the model doesn't look much like its prototype. How, then, is it established that the model acts like its prototype?

Consider the accompanying graphs. The solid-line curve in each graph represents a known event: the highest elevations reached by the water during the 1936 Johnstown flood. No conjecture or calculation enters that curve; it is compiled from gage heights actually observed and recorded. The dashed-line

curves also represent data actually observed-but on the model, not the prototype In each case, there was being discharged through the model quantities of water corresponding accurately to the quantities which deluged Johnstown in 1936. The experimenter reasons that, were his model acting correctly, the dashed and solid lines should coincide He takes steps to obtain the desired coincidence, these steps consisting chiefly of roughening and smoothing operations. His progress the middle and lower graphs. The latter he accepts as satisfactory, and, secure in the belief that his model is acting correctly, he proceeds to the testing of the proposed plans. Incidentally, having successfully adjusted (or "verified") his model, the experinienter's worries are largely over Figuratively speaking, the testing of plans involves only the turning of a crank on a machine which it has taken months to build, calib-

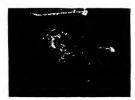
rate, and adjust.
(As a matter of interest,
not strictly pertinent to the
discussion of verification,
there is plotted on the lower
graph data indicating the
effectiveness of the improvement plans. This curve represents the crest of a flood

identical to the one of 1936 but occurring in a channel like the one proposed,)

IT will be observed that the anallscale model is a very practical instrument. That is, it is designed and adjusted so as to aid in solving a specific problem—such as the flood situation at Johnstown. It contributes only in relatively minor, degree to the advancement of abstract science. It is, in fact, only a semi-sevenific instrument. That being the case, it is found not in institutions devoted to the development of fundadevoted to the development of funda-



Model analysis of a spillway problem. The object of the engineers was to reduce water velocities and eliminate dangerous areoin oblow the dam. At the left, velocity was high and scour so had as to cause much crotion. The model was then modified to produce lower velocity (right). Result was negligible erosion



mental truths, but rather in agencies charged with the prompt accomplishment of real projects. Thus, the Bureau of Reclamation maintains a modelanalysis laboratory at Denver, and the TVA maintains one at Norris. The Corps of Engineers of the Army, charged as it is with the improvement and control of most American rivers and harbors, conducts model analyses in various laboratories, the largest of which is the U. S. Waterways Experiment Station, at Vicksburg, Mississippi. The photographs and figures accompanying this discussion relate to the latter laboratory. A further glance at its current operations will afford examples of most types of problems to which model-analyses are applicable.

Man constructs dams across rivers with various purposes m view to regulate the stream flow in the interests of navigation or flood control; to concentrate head in the interests of power development; to conserve water in the interests of irrigation Conduits and spillways frequently present perplexing problems, among which are the precautions to be taken to prevent dangerous erosion. The danger of erosion arises from the discharge at high velocities of water through conduits or over spillways. The problem is to reduce these velocities before the water reaches the soft materials of the river valley. In such case, the model-method of analysis

is easily and directly applicable. To describe by illustration, consoit two of the photographs on page 141 that have to do with a model of the spillway for the Creat Salt Plains Dam, about to be constructed on a tributary of the Arkanasa River. One of the photographs shows the high-velocity discharge onto the erodible material; the other shows the results of provisions for the "stilling" of the light velocities. Relatively speaking, the erosion has been made negligible.

IN their natural states, few rivers are susceptible of econome awayation Most of them must be "improved", that is, made deeper Their are several methics and of improving rivers for pavigation by cambration, as on the Ohio and the upper Mississippi; by increasing the critical of low water flow, as on the Mississippi when the Mississippi water flow, as on the Mississippi flow of the Mississippi chows the June 1990 of the Mississippi flow St. Louis

Description of the open-river method of improvement movless consideration of the elements of an alluvial river. Such a stream consists of long, relatively deep pools, these extending along the concave sides of the river lends. Between successive pools are short, relatively high, "crossing" har? In effect, the river is a series of flat, deep reservoirs, or pools, the water from one reservoir spilling into its downstream neighbor over the steep, shallow, crossing bar. Thus, the

situation facing the navigator is this: through perhaps 95, percent of his course he is in a channel liaving several times the depth his vessel requires; but, through the remaining 5 percent of the course he is crossing over bars where the depths very likely are less than he deares. The object of open-river regulation is to provide such training works as will cause the river to erode deeper channels over its crossing bars. In such a case the method of model-analyses folls an essencially great need.

Man attacks his flood problems in various ways. by impounding the excess waters and releasing them only when they will do little or no damage, by increasing the capacity of the river channels; by constructing levees which exclude the water from restricted areas. The small-scale model is a valuable tool. both in enabling the engineer to select the method of protection best adapted to the situation at hand, and in aiding him to develop details of design after the method has been selected. Two more of the photographs show the model reproduction of a bridge at Johnstown. one illustrating flood conditions at 12:30 A.M., March 18, 1936, while the other presents the improved channel takmg all the flood water. Business in town goes on as usual

The mafavorable deal which Nature provides in connection with its livers is repeated in connection with its harbors. The tides, the occan currents, the waves, and and the bed materials blend together to form a phenomenon which man perceives clearly only in its re-altant form. In the face of such complexity, the small-sale model is of only limited reliability, but so difficult are the problems that the and provided by a model, even of limited reliability, frequently is valuable

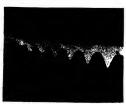
Thus, in the manner indicated by the camples cited, the profession of hydraulic engineering marches on, its progression of progress over many of its most difficult obstacles being lighted by data from small-scale model experiments. One can say the same thing in another way; which is the baffing complexity with which Nature endows flowing water has found to the complexity with which can be completed by the complexity of the complexity with which can be completed by the complexity of the same conditions of the small-scale model.





Above: Waves impinging on a model of a breakwater. Such waves as these must not enter the harbor

In the Johnstown model: a bridge past which flows the equivalent of the 1936 flood. At the left is the condition as it was and at right is shown the lower stage heights of the great flood with the improved channel



No More Blown Patterns

A SHOT-GUN shell recently announced, which will eliminate blown patterns, means much to term the short patterns and the short patterns which the short patterns with the short patterns and the short patterns and short the short patterns and short patterns and short patterns and short patterns and short patterns out of every 100, made with conventional shells, which unaccountably are much more widely scattered or "blown" than the others.

In the ordinary trap load, for example, 90 shells out of every 100 would put 60 to 80 percent of their pellets into a 30-inch circle at 40 yards. But the remaining 10 shells would all be below 60 percent And three of four of these would seater their pellets so widely that barely more than 30 percent of the shot charge would get into a 30-inch circle at 40 yards. Even with the best of gun pointing, it is obvously shere luck whether, with such a pattern, the clay target is struck by some of the

Top Wad in Shot-Gun Shell is the Villain That Causes Them . . . Elimination of Wad by a New Crimped Shell End . . . Unimpeded Shot Charge

pellets or whether it flies blithely through one of the numerous holes.

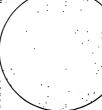
Thousands of patterns have proved that the top wad is the villam in this story. With the top wad shead of it, the shot charge rushes from the muzzle at about 1200 feet per second. The terrific resistance of the air on the flat surface of the top wad at this velocity checks it's speed and causes it to get in the way of the shot. Most of the time it slides along the outside of the shot charge or is hipped entirely out of the

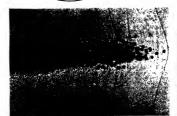
way and does little damage. But, about ten times out of every one hundred, the top wad obstructs the column of shot, and a blown pattern results. Shells with the new Remington Crimp

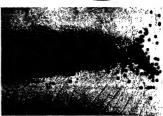
avoid this effect, because they contain no top wad to get in the way of the shot column. They have exactly the same contents as are used in ordinary-crimp loads at present. To provide means of load identification and to waterproof the shell, a waxed paper disk only three one-thousandths of an inch thick is pasted to the crimp closure. On firing, the shot charge pushes the top open and breaks the disk into six pieces These remain affixed to the shell body. Hence, from the very beginning, the shot charge is completely unobstructed in its flight toward the target, and produces a blowproof pattern.



Above: Shotsum shell at right is for reaventional type in which the top wad causes occasional blown patterns. Other three shells show steps in folding and sealing the rimp of the new shell described. Lower right: The spark photograph shows how the top wad breaks up the shot charge. resulting in a blown patter such as shown at the right. Lower the continuous shot charge coming from the new type shell. Such a charge produced pattern at left









Photograph by Jacob Deschin
The illustration above, taken at a recent meet, shows
one of the competing planes an instant after leaving
the starting table. It has started from a standstill
under its own power. Below. A Syncro

Ace Special, less than five inches high



MINY gasoline engines with an average weight of only six ounces, a height of four inches, and a horsepower rating of one sixth are furnishing the motive power for proportionately small airplanes which have made remarkable endurance, distance, and altitude flights. The engines form the basis of a hobby which is daily attracting new recruits of all ages to the ranks of the gas-powered model-plane enthusiasts. It has been estimated that there are more than a thousand clubs in the United States in which membership is exclusively confined to those model-plane flyers whose ships are gasoline powered. Doctors, lawyers, business men; all professions and crafts are represented in the ranks. They have taken the small plane from the classification of a bov's plaything and made it the foundation of a serious pursuit which helps to pay weekly wages in hundreds of retail hobby stores, in the factories where motors are manufactured, and in shops where plane equipment and materials are produced.

The hobby offers triple fun. First is the pleasure of building the planes and

UP IN THE AIR FOR A HOBBY

Half a Pound of Power . . . Avocation Makes Big Business . . . Inexpensive Midget Motors by Mass Production

By L. B. POPE

second the thrill of secung them fly, The flights give a sense of adventure, and many an altitude record or transoceanic hop has been made vicariously More important, though, is the very real toy of competition; flying the plane in one of the frequent inter-club or intraclub meets. Each "aviator" keeps formost in his mand the hope that his plane will someday establish an official record which will serve as a goal for the thousands of other model-plane enthusiasts throughout the country.

The reason for the recent increase in interest in gasoline powered model airplanes is not hard to find. The story is the familiar one of mass production making available a quantity of some product at a price within the means of all interested. The gasoline motors on the earliest model airplanes represented hours of careful planning and work. They were beyond the average model (an who had neither the equipment, skill, time, nor money necessary for their construction. But modern shop practice has changed the whole picture in favor of those who would fly gasolinepowered planes, but who for one reason or another cannot design and construct a suitable engine.

THE modern little power plants that are constantly setting new model records are carefully engineered working miniatures of those two-cycle gasoline engines commonly used for outboard motors, small water pumps, power lawn mowers, and so on. There are many manufacturers who offer a variety of designs and hence there is a wide price range from which to select. Partially assembled engine kits, requiring only a screw-driver for complete assembly, at about \$5 is the minimum. Complete motors with batteries, coil, tank, and accessories are priced up to \$22. The motors are rated at from 1/7 to 1/2 horsepower although they are only three or four inches high and weigh but a fraction of a pound when unstalled. To arrive at a clearer idea of what a model-plane motor really is. 16 typical camples were selected and their characteristics averaged. The results give a hypothetical motor weighing six ounces, slightly less than four mehies high, with a horsepower rating of 1/6 at 8000 revolutions per minute. The hore and stroke are each 3/4 inch. (Of the motors used to obtain these average figures only five had equal stroke and bore dimensions.) It would cost \$13.64 to buy this imaginary composite motor.

cost of the model power plant, ready to

be put into a plane and run

Since this composite and average motor is only four inches high, the component parts are tiny indeed, yet standard machine shop practice is followed in the manufacture of all the various small parts. Most of the crankcases are die cast. Cylinders and pistons are usually machined from the solid, then hardened, ground, and lapped to fit. The pistons are smooth wall or with one or two piston rings Connecting rods may be die cast or steel drop forgings. with hardened and lapped bearing surfaces The crankshaft, drop forged or machined, has usually only one solid bearing area. (Some manufacturers advertise ball bearings at slight additional cost.) At one end of the crankshaft is the connecting rod and the counter-balanced crank; the propellor is on the hub at the other end. Between the two is the bearing, an inch or two long, of bronze or steel. A balanced flywheel, grooved for rope starting, is sometimes used on the 1/5- and 1/4horsepower motors.

A glance through the advertising literature of model engines will reveal such phrases as chrome-molybdenum crankshaft; tool-steel crankshaft; cadmium-plated head; aluminum piston; micrometer needle valve; bronze bearings; transparent gas tank; or perhaps

the maker will stress the fact that his particular model may be run either upright or inverted, a fact which might influence the model builder who has ideas for motor cowling. Thus does competition in this field, as in many other sumer. In order to attract the public, each manufacturer constantly strives to improve his product.

The fuel system of these model-plane motors includes a gas tank, a needle valve, and an intake manifold. The tank may be of metal or some transparent material and is supported in back of or under the cylinder. It holds only a few ounces, as very little gas is required for the motors. The fuel is usually a mixture of gasoline and motor oil (S. A. E. No. 70) in the proportion of four parts to one. The fuel passes by suction through the needle valve and into the crankcase, where the oil luhricates the main bearing and other moving parts, and then into the combustion chamber where it is burned.

The electrical circuit of the motor includes batteries, coil, condenser, contact points, and a spark plug. Small flashlight dry cells are used to supply the necessary three volts. The coil and condenser together weigh only two or three ounces and furnish the hot spark which ignites the gas. The contact points are on the driveshaft directly behind the propeller and make contact once every icvolution Spark advance or retard, as may be necessary for proper operation of the motor, is accomplished by moving a lever located behind the hub. The lever shifts the ignition points forward or backward to make earlier or later contact. The spark plugs are made by several manufacturers, but are of standard sizes about one inch high and with 3/8-24 or 1/4-32 threads.

The planes which carry and are powered by these small engines usually are the results of hours of labor on the

At the right, an Ohleson motor showing how the coil and con denser are connected Below. A Syncro motor with the gas tank as part of the streamlined crankcase assembly. Below, right: The baby Cyclone motor has a remote control throttle and a rotary intake valve



part of the owner. They may be bought complete or in construction kits, but frequently they are the embodiment of the hobbyist's own ideas and the result of much personal experience.

With many different sizes and shapes of gasoline-powered model planes, some sort of regulations must exist in order to run competitions on a fair basis. Thus the National Aeronautic Association, Model Division, has established contest classifications, and rules governing them, for all model planes including gas—powered types.

The models are classified according to the area of their supporting surfaces, most

supporting surfaces, most gas-powered models are in "E" class with an area of more than 300 square mohes. All regulations are kept in mind while the plane is building, otherwise it will not be licensed and qualified for officially sanctioned meets. There are regulations governing minimum an examinum weight, cross-sectional area of fuselages, and wheel size. The landing gear must be demonstrated to be strong enough to support the plane when gliding to a landing from a height of four fret, without damage and without noung over

THE serious and adult nature of the hobby is shown by the official classification of contestants. No one under 16 years of age may compete without special permission and supervision. Records made by model planes are not







Photograph by Jacob Deschin

Details of plane construction. The large dry
cells shown on the ground serve merely as an
engine starting aid and are detached before flight

official until they have been accepted by the Contest Board of the National Aeronautic Association. Official recognition is given to duration records only. All official records must be made in sanctioned meets or under specific direction of the Contest Board of the N. A. A New records must exceed the old ones by 2 percent in order to qualify for recognition.

Official contest flights are made by allowing an engine run of 20 seconds. the time being limited by either a mechanical flight timer or by fuel measurements. In that time the plane must take off from a standstill and climb as far as possible. After the motor stops, the plane glides to the ground. The flight duration is timed from the instant the wheels leave the ground or starting table until they hit the ground. An indication of what these little planes can do is the winning time of a recent meet. First place was won by a flight lasting 20 minutes and 20 seconds. This means that the plane was so nicely trimmed that it soared in the air without any power for exactly twenty minutes Other non-competitive and non-official flights without the 20-second motor run limitation have been made which lasted more than two and a half hours. A welldesigned gas-powered model plane may cover 50 airline miles and soar to a height of more than 10,000 feet.

The surest way to antiagonize any devotee of this universal hobby is to refer to his ship as a 'top plane,' for they cannot truthfully be called toys in any sense of the word. The gas-powered model plane enthusiasts are a hard working and serious let.

A For those readers who want to obtain more specific information on this interessing hobby, and further details of planes, motors, and equipment, a list of manufacturers and dealers will be sent on request. Please enclose a stamped envelope.—The Editor.

A Remarkable Triple Star

VERYONE knows that hundreds of double stars have been detected by the spectroscope. As the stars move in their orbits, they sometimes approach us, and again recede, and the positions of their spectral lines shift accordingly. By following these changes, we can find the period of revolution in the orbit; but to work out its size is not so easy. If the orbit is turned edgewise toward us, the motion at certain points will be directed straight toward the Earth or away from it, and the spectroscopic observations will reveal the true speed. But if the orbit is tilted at some other angle, there will be no point on it at which the motion is in our direct line. Even at best, a large part of it will be sidewise, and only a fraction (in technical phrase, a component) of the velocity will be in the right direction to shift the spectral lines. In the extreme case when the orbit-plane was squarely at right angles to our line of view, there would be no change in the distance, and no Doppler effect, however rapid the actual motion.

It follows that spectroscopic observations can give us only minimum values for the real speed, and the real size of the orbit But this is not all, the two stars of the pair, as Newton showed long ago, will move a Newton showed long gravity, keeping on opposite sides of it, in m orbits of the same shape, but different sizes. The more massive star will have the smaller orbit, and move slower.

With two stars of about the same brightness, both spectra will be visible on the plates—one shifted to the red when the other is deplaced to the volet —so that the dark lines appear double, and considerably "washed out" by the superposition of the continuous spectrum of the other star. In such a case we can find the distance of each star from the center of gravity and their distance from one another—still subject to an inknown correction for the orbital inclination.

It is only when the two stars eclipses one another that all uncertainty can be removed. In this case the melination can be removed to the stars, the start of the stars, he had been also their next all diameters and their masses. There are about 30 yeatems for which this full information is available. Almost all these stars are larger and brighter than the Sun—for the fairly obvours reason that bright stars can be seen at great distances, and have an our observing lists than those which shine (cebly.

How the Spectroscope, Working on a Star Whose Secrets the Telescope Does not Reveal, Affords a Striking Abundance of Detailed Facts

By HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University Research Associate of the Moun

They are mostly hot white stars too and again the reason is intelligible. A white star gives out a great deal of light per square mile. If it has a fainter companion of different color and temperature, this will be redder, and have a lower surface brightness, so that, though fainter, it may be as large in diameter. or even larger than its primary. This obviously sets the stage for a conspicuous eclipse, if only the inclination of the orbit is favorable. But if a bright red star has a fainter white companion, the latter will be of very much smaller diameter. If it comes in front of its big associate, it will obscure so small a part of its light that the change is most unlikely to be detected; and when it goes behind, only its own light a small percentage of the total for the pair-is cut off. Hence, even if eclipses occur, they are likely to escape observation, unless conditions are unusually favorable. The remarkable system Zeta Aurigae, in which the big red star is more than 20 times the diameter of its white companion, is one of these exceptional cases

DUT if there is a pair of stars of other benearly equal size and brightness, the chance that they will eclipse one another depends only on the orbita being nearly edgewise to us, and it should make no difference whether the stars are white or red. We actually find many such pairs of white stars, and plenty of yellow and reddish ones too—but the latter are all dwarf stars of about the size and brightness of the Sun, or smaller.

smaller.

But eclipsing pairs in which both components are guant stars of low density are very rare. This suggests that it must be decidedly unusual to find a double star composed of two red or yellow guants, and among the far wider pairs, which are resolvable with the telescope, this is the case. Occasionally we find a pair, such as Camma Leonis, in which the two are of about the same brightness and color. But the great majority of doubles among the giant stars have companions much fainter than themselves.

and usually "earlier" in spectral type and whiter in color.

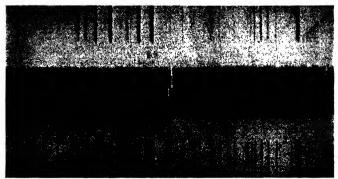
The same thing is found among spectroscope binaries. There are very few giant stars which show double lines, and have companions similar to themselves. Capella is a conspicuous exception, but a rare one. Usually only one spectrum can be seen and we are left with no way of estimating the real size of the orbit or the masses of the stars. Once in a while, luck flavors us.

For example, the third-magnitude star Beta Capricorn—which has a spectrum of Class G, like Capelle—was found by Campbell in 1899 to show changes in radial velocity, which later proved to have a period of 1375 days, or 33 years. Only one spectrum was visible. An orbit was calculated, showing that the distance of the bright star from the center of gravity of the system was 2½ times the Earth's distance from the Sun (plus the allowance for the unknown inclination) and the star was tactily placed on the list of those about which we had found out all we could all we could all we could all we could be a spectrum.

But, in 1935, three new spectra were taken by Sanford at Mt. Wilson on successive nights. These extended farther to the violet than the earlier plates, and showed the great H and K lines of calcium.

Layten, to whom the plates had been sent, noticed a remarkable thing. The H and K lines in a G-type star are normally very wide and diffuse and very strong. In this star they were weak and shallow, with narrow, fairly sharp lines in the middle. What is more, the sharp H and K lines slowed a conspicuous displacement in two days, compared with the numerous lines of the main spectrum.

Sanford then began to observe the star steadily and soon found that these calcium lines shifted periodically in a period of between eight and nine days, it was now evident that this is a triple system. The new lines belong to the fainter component of the system of four year's period, which is itself double, with a period of 8.678 days. It is a much



Courtest The Autrophysical Journal
Two spectrograms of Beta Capricorni (the two-part central area of the illustration) taken two days apart and adjusted for
coincidence of line detail of star A. Strong K lines of calcium seen at the center of the half-one belong to star B and are
definitely out of step. The present semi-popular arcount is hased on the paper by Sanford, published in The Astrophysical
Journal, Volume 89, No. 3. In that journal the American professional astronomer publishes the official accounts of his
researches but, since these are written for the scientist, they often are abstrace and Professor Resuled explains them here

fainter than the principal star that its lines would be completely masked by the stronget spectrum of the latter, were it not that those two lines fall in the middle of great wide dark lines in the other spectrum, which afford a "window" through which they can be observed. Three silteon lines belonging to the fainter star (B) and showing corresponding changes in velocity have also been detected in a "window" formed by the strong cyanogen band in the G-type spectrum of star A.

The strength of these lines of sonized when, and the narrowness of the calcium lines, show that star B must be much hotter than the first—of Class Bis—like Algol. A spectrum extending to 3200 in the ultra-worlet shows that, in this region, the light of star B is considerably stronger, in comparison with that of star A. Thus is as might be expected.

No lines belonging to the third body C have been detected. It must be considerably fainter than the second.

If this interpretation is correct, the velocity of the center of gravity of the close pair, BC, should show changes in the four-year period, always opposite in direction to those of star A, so that when plotted they should show a curve of the same shape, but upside down. Sanford's observations have now been continued over almost a whole period and they show conclusively that this is the case The proof that we have here a triple system is thus completed.

The observations of the wide pair now cover 40 years, and make it possible to

find an accurate period, 1374 days. The orbit has a considerable eccentricity (0.42). The minimum value for the distance of star A from the center of gravity (on the assumption that we see the orbit edgewise) is 395,000,000 kilonieters or 2.65 times the Earth's distance from the Sun. The pair B + C is on the other side, at a distance of 360,000,000 kilonieters (241 astronomical units) The size of the relative orbit comes out therefore nearly that of Inputer's orbit about the Sun. As the period is only one third of Jupiter's, the masses must be much greater than the Sun's. They come out 4.35 times the Sun for star A, and 4.77 for B and C combined

(If the mclusation of the orbit plane is t, the distance given above must be multiplied by cosec t and the masses by cosec t. For example, if $t = 60^\circ$, the distance of the star comes out 60 astronomical units and the masses 67 and 7.3 times the Sun's.)

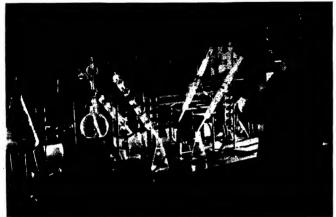
The orbit of B about the center of the pair BC is moderately eccentric (e=0.36 but is small, with a radius of 4,200,000 km. if it is seen edgewise) It can be shown from this that star C is, in all urobability of small mass.

Working, as an illustration, on the assumption that the inclination of the larger orbit is 90°, we have the combined mass of BC 4.77 times the Sun's. For this mass, and a period of 8.68 days, the distance of the components can be calculated and comes out 21,200,000 km. If the inclination in the small orbit is taken to be 90°. C is found to be 17,000.

times as far away as B, so that the mass of B is 40.5 times that of C, which makes of B is 4.05 times that of C, which makes the masses 3.93 and 0.95 times the Sun's. With different assumptions regarding the melinations, different tesults would be reached; but, unless we assume that the orbit of the wide pair is seen almost edgewise, and that of the close pair at a small angle, the mass of C always comes out small compared with B.

T-BHS accounts for the failure of its keyertum to appear, for by the well-known relation the luminosity of a star varies about as the cube of its mass (Recent work midicates that the 3.3 power is a better approximation.) On this basis, if B is four times as massive as C, it should be a hundred times as breight

Comparing A and B, on the assumption already made, we find that the latter has a mass 90 percent as great and should give 70 percent as much light. It appears to be considerably fainter than this; but a moderate and wholly permissible alternative in our assumption about the inclinations of the two orbits would lead to complete accordance The only hope of clearing up this uncertainty lies in the possibility that one or other orbit is so nearly edgewise that eclipses occur For AB this would demand an inclination so very near to 90° as to be highly improbable; for BC the chances are rather better, but the light of A would drown out the variation so that very precise observations would be needed .- - Princeton University Observatory, June 14, 1939.



Courtesy The Borden Company

Equipment for chlorophyll and vitamin research in a biochemical laboratory

Secrets of Life's Colors

COLORS are clues to life's most fascmating mysteries. Green, red, and yellow—the most meaning-ful life-colors—are guiding scientists through regions in which Nature, by the changing beauty of light waves, signals the locations of treasure caches.

Many of these treasures are turning out to have immediate cash value. Many are discoveries which promise other stores of knowledge that will stimulate civilized progress and some day will alter the modes of man's existence.

Plant green, the pigment chlorophyll, seems to be leading man toward great manufacturing secrets and the ultimate production of both fuels and raw materials as well as foods in almost unlimited quantities. Experiments are beginning to teach man the mechanisms of energy use and fuel production in green plants. Many of the details are already known. When many more are known, then foods, raw materials, and fuels will be almost as cheap as air and water and sunlight. Even now, chlorophyll has practical value. In this country each year thousands of pounds, extracted from leaves, are used to color foods, soaps, Chlorophyll, Key Substance of Life, Mysteriously Concentrates and Stores the Sun's Energy... Gives Promise of Vast Resources to Industry

By BARCLAY MOON NEWMAN

and candles. To medical science, chlorophyll is of inestimable, immediate significance. The architecture of its big molecules is amazingly similar to the architecture of the molecule that runs red in blood.

Green, the prime pigment of the plant world, is most intimately related to red, and a superior of the plant world, is most intimately related to red, and a superior of the plant pl

animal red are abnormal and puzzling. Yellow is as widespread and as important as green, though masked by the chlorophyll of vegetation. A light filter which absorbs most of the green rays from chlorophyll but permits the passage of other light has been devised by the Eastman Kodak Company. A green field or a green forest observed through this filter is a fiery yellow admixed with orange and some slight red. For in every green plant cell there are yellows and yellow tinged with orange and red. When aviators, intent on dropping bombs, observe the landscape through this special light filter, the green of vegetation looks fiery vellow-but the green paint of camouflage still is green,

and there is no yellow. Because of this

difference between greens-a subtle dif-

ference made evident by the filter—and because of the presence of hidden yellow in the one case and not in the other, the bombers know where to loose their destruction. This application of pure science is practical—and of immediate value—if you call war practical and bombing valuable.

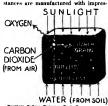
Definitely practical and definitely of inestimably great immediate value are science's new facts concerning these yellow pigments. For, chief among plant vellows are the carotenoids-source of the millions of dollars annually spent to obtain vitamin A, the essential nutrient derived from carotenoids. And who can put a price on the vitality and health that medical science has brought us through its increasing understanding of carotenoids and vitamin A? Certain internationally famed experts, besides, are convinced that vitamin A is one factor in the problem of lengthening the span of human life.

The value of carotenoids to the plant still unknown, but their occurrence is related to rapid growth and high activity, as in the green leaf, where photosynthesis is under way. Green chlorophyll is never found unaccompanied by these mysterious compounds. Probably their secrets are bound up with the problem of photosynthesis—where chlorophyll has a role of predominant significance.

Green is spread extensively over the earth. This abundance is a sign that the greenness of the chief plant piguoni, chlorophyll, is indispensable to practically every form of life on this planet. Chlorophyll is an indispensable promoter of the transmutation of solar energy into the energy of life activities. Without it, there would be no food, no coal, no oil, and no men. An enlightening and fascinating quiz is to ask a succession of questions tracing back to the origin—the Sun—the energy in the various prominent items of our dietary, fuel, and raw material economies.

PHOTOSYNTHESIS—the synthesis in plants of sugars and other nutrients by the use of sunlight, is almost uniquely interesting as a chemical problem-and almost uniquely complex, too. In this process, the living tissue of the plant absorbs molecules of water from the soil or perhaps a watery habitat. Rays of light energy plunge in from the Sun. The plant uses green chlorophyll to deal with these rays. That is, chlorophyll somehow manages to concentrate their energy and to store it-probably by stimulating the reaction of water molecule with carbon dioxide molecule. The reaction of these molecules results in the formation of sugar and starch, which are energy-rich molecules. Oxygen is a by-product poured out into the air and later becomes the very breath of every creature. If it were not for photosynthesis, the quantity of oxygen in air would gradually diminish and, so runs the evidence, life would vanish almost entirely.

After photosynthesis, by intricate steps sugar is made to yield a van list of maternals needed by life. Thus, from sugar, by fermentation in the plant cells, alcohol is made, and afterward participates vitally in the chemical reactions whose sum is life. Sugar likewise is the raw maternal for making glycerine, oils, fats, proteins, vitamins, pyments green, red, and yellow. All these substances are manufactured with impres-



Courtesy College Entrance Book Co The green plant cell takes in carbon dioxide and water and, with the aid of chlorophyll (in tiny chloroplast bodies) combines them to make sugar and starch. By-product: oxygen

sive efficiency out of the prime product of photosynthesis: sugar, whose energy came from the Sun and whose atoms once were water and gaseous carbon dioxide. Photosynthesis is the world's most efficient process.

Investigation shows that there are, in fact, two green, having very nearly the same art hitecture of molecule: chloro-phyll a and chlorophyll b. When extracted and crystallized, a is blue black; in alcoholic solution it is greenish blue. The solid crystal of b is green black; it dissolves in alcohol to a beautiful pure green. Readily a is changed into b by delicately taking away two atoms of hydrogen and replacing them with an atom of oxygen. The life scientist motes that they are always together in any green plant cell; each is an essential cog in the machinery of photosynthesis.

Each chlorophyll molecule is a web of carbon, hydrogen, oxygen, and nitrogen atoms, with an atom of the metal, magnesium, as a centerpiece and chief feature, when the molecule is taking part in photosynthesis.

The red hematin structure is also a web of carbon, hydrogen, oxygen, and nitrogen atoms, but with an atom of the metal iron as a centerpiece and chief feature, when the molecule is taking part in the transport of oxygen in living things.

To ferry oxygen is the destiny of the hematin architecture. That it makes blood red is a mere happy signal of Nature—not always so eager to help man by arresting signals. The disk-like blood corpusele is red because its activity is the transport of oxygen, and this activity calls for hemoglohm—a giant globm, or protein, to which four molecules of hematin are, butched

The pallor of anemia is another signal, this time of warning, that the body needs more iron in its blood, iron in the form of hematin.

Where oxygen is plentiful, as in the lungs, hemoglobin forms a loose combination with it. Where oxygen is low in concentration, as in the tissues deep within the body, the oxygen atoms break away from the lemoglobin and are absorbed into the tiny laboratories of the cells. There the oxygen is used to burn, to react with, the fuels and release their energy for running the mechanisms of life. These fuels were formed originally in the plant, by the aid of green chlorophyll in photosynthesis, and originally their energy was sublight. All fiesh is grass, which labors in the sun.

THE iron atom, central feature of the lienatin molecule, as empowered to attract a molecule of oxygen—two atoms and seize it, holding it in the web until the appropriate time of release. Thus the huge henoigholin molecule, having four hematin structures attached, can hold four molecules of oxygen at a time. Each red corpuscle, having many hemogloin gaints within its delicate fabric, can carry many oxygen atoms. The transportation of oxygen to the hungry cells fair from the lungs as therefore an effect at the contract of
No seventist thinks that the close likeness of hematin and chlorophyll is an accident One ancient day, when earthlike was young and low in type, live substance realized the possibility of exchanging an atom of iron for one magnesium in a web like that of green chlorophyll. Oxygen-ferrying was facilitated. Red blood, and its possessor, the higher animal, could later appear on earth.

New discoveries yield striking evidence favoring this theory. Man cannot exist without minute quantities of copper and manganese in his system. These metallic elements, it has recently been found, promote the formation of hemoglobin in factories located in hone marrow. And lately, too, it has been found that chlorophyll formation does not take place in the leaf in the absence of minute quantities of copper and manganese.

Now color leads us—as it did the investigators of the mystery of life—to one of the major discoveries of science. Throughout all matter that is alive, hematin is found—in the bacterium, in the towering redwood tree, in the aquatic animalcule ameba, in man.

Why, then, is not all living material red? The hematin is present in too low

a concentration to cause any color to show up

Nevertheless, the high sensitivity of the spectroscope sorts that light waves made to pass through live matter and invariably finds those wavelengths which tell that hematin is definitely there, though in proportions almost infinitesimal. Still, distributed however thinly through vital substance, the hematin molecules-we now know--make possible a vastly complex mechanism of energy use. The hematin web is continually busy taking oxygen from this molecule or that, and ferrying the oxygen to other molecules-which then react, usually by uniting with the oxygen, and so are oxidized, burned to release heat or other varieties of energy.

Thus, one great mystery of life is slowly beginning to give up some of its treasures. Oxidation and energy transformations at moderate temperatures constitute a secret not only universal in living things but also thrilling in promise to man. Cold, white light like that of the firely and deep-sea monster will be soft illumination in man's buildings when he solves more problems of the most efficient conomy in the world—the physico-chemical economy of animate machinery, which with automiding ease stores energy in photosynthesis or re-leases it in physiological oxidation.

SOMEWHERE in the rise of animals, protoplasm learned to put copper in the place earlier occupied by room in the hematin web, and thus made a blue from a red. The oxygen ferries—that is, the respiratory pigments—of the blood of the octopus, the oyster, and the lobster are hemocyanins and not hemoglobins. They are blue, not red.

Other lines of animal evolution used the red hematin to make their blood pigments and so were able to go lingher in the scale of life. Hemoglobin is four times as efficient a carrier of oxygen as hemocyanin, and is one of the factors in the creation of man out of lower mechanisms. Yet to this day, copper is somehow bound up in the making of hemoglobin.

Yellows outstandingly important to life are perhaps most readily seen in the carrot—from which these pigments were first solated, and so called carorenoids. They are vital to the plant and to man—and were the sole source of vitanin A until the eminent biochemist Kuhn recently taught chemists how to make this vitanin in the test tube.

In 1831, ruby-red crystals were extracted from carrot root, and named "carotin." This pigment is now recognized as a mature of at least three closely related chemical structures: alphas, beta, and gamma-caroten. In solution, the red changes to the yellow typical of dissolved or suspended molecules of carotene—as in a number of yellow flowers, in the volk of the egg, in the yellow leaf. But not all plant yellow is carotenoid; not all carotenoids are yellow.

A carotenoid is a special chemical structure a ring of carbon and hydrogen atoms attached to a chain of carbon and hydrogen atoms attached to a chain of carbon and hydrogen atoms. The ring is known as the beta-lonnoid ring, and holds many a recent Chemists first knew it as an essential portion of many a fragrant molecule, such as those many a fragrant molecule, such as those mind of wolets. They are surprised to learn that it is a vital part of the structure of vitamin A.



Science Service photo President James B. Conant, of Harvard (right), internationally known investigator of chlorophyll. (At the left. Dr. Harvey Cushing, surgeon)

The length of the chain, and the manner in which its atoms are linked, have much to do with the color. Yellow is predominant among these substances, but slight changes in the positions inkages—of the atoms and an increase in the length of the chain yield orange, red, and then even reddish violet and very rarely dark blue. The red of tomatices and of waternelons is, for example, a carotenoid—kin of the yellow of yellow to the color of green-masked yellow of all leaves. Vitamin A, however, is colorless—no one knows why.

In the backboned annual, any one of the three earontees can act as the forerunner of vitamin A. The liver accums to the three tearners of vitamin A. The liver accums to the same of this transformation of yellow mote colorless on parents with the vertebrate can set no parents which the vertebrate can set no parents which the vitamin A. The vitamin of yellow the vitamin A. The vitamin of the vitamin A. Causes however of relationship of the vitamin A. Causes however of relationship of the vitamin and mucous membranes, poor vision of dim light, weak dry eyes, and ultimate blundroses.

Eggs and milk have vitamin A derived from the animal's ration of plant yellow, or perhaps of cod-liver oil (added to the feed). The cod eats lesser aquatic life, which in turn lives directly or indirectly on sea vegetation which has both green for energy storage and yellow for vitamin A. How intricately woven is the web of life! Blo-science, medicine, chemistry, and eventually even physics (through the study of color's origins) will all amazingly benefit from present and future investigations of yellow, so closely tied up with green and the wellbenz of men with red blood.

The common yellows of fruits, vegetables, and flowers are carotenoids, but there are other yellows. A yellow scarcely yesterday discovered present in practically all living tissues, plant or animal, is vitamin G, or riboflavin, most readily obtained from nulk, a rich source and, in fact, until recently the sole commercial source. What rôle this vitanin plays in extending the life span of man is unknown, but the mouse and the rat definitely live longer when plentifully supplied with the untrient. Until recently, riboflavin obtained by a laborious process from milk was selling at many dollars per gram -- and there are 454 grams to the pound. Thus important did biochemists and medical scientists regard the vitamin. Now, thanks to improved production facilities and commercial synthesis, the price has been much reduced.

THIS yellow takes us back to red. Like hematin, riboflavin is essential to the release and transfer of energy within the vast systems of the life mate rial. It is beginning to appear that in this yellow we have a link between the vitamins and the enzymes, which are the stimulators and accelerators of chemical activities within a living thing. Riboflavin, attached to certain huge protein architectures, endows them with the power to step up the rate of burning and energy- and atom-enchange in many vital chemical reactions. Hence riboflavin, the yellow, is a companion of and co-laborer with hematin, the red, in the control of life's breakdown of fuels.

The world of life is a world of color.

And the ho-investigator is finding profound meaning in the play of color.

The human eye that looks out over this
world is struck by a myriad of clues to
Nature's deepest and most significant
secrets. And the very eye sees by grace
of the pigments that signal so fascinatingly.

Vatamin A, born of yellow, is a partial of the mechanism of the human retina, the light-sensitive photographic film, as well as a part of visual purple and other evisual pigments known to exist, but still jump mysteriously, in the eye's photosensitive will be mysteriously, in the eye's photosensitive film. The red which vitalizes the brain and nerves and eye is the offsyring of only living mechanism of man, yellow and horized are specifig the use of the energy which green following the properties of the energy and which green following the distribution of man, yellow and which green following the distribution of the energy and which green following the distribution of the energy and the summer. Scientists find much profit in such thouse the sentence of the

WHAT SIX YEARS DID

In the Design of Large X-ray Equipment, Progress Has been Extremely Great in the Past Few Years... Hospital X-ray equals \$90,000,000 Worth of Radium

A MILLION-VOLT X-ray outfit to small that it can be housed in existing hespital buildings, yet so powerful that it gives X-raduation equivalent os everal thousand grams of radium, has been built by the General Electric Company for the Memorial Hospital in New York, where research in the treatment of cancer is being carrier don. It is estimated that the radiation from it, based on present-day radium costs of \$25,000 per gram, will be equal to \$900,0000 worth of radium.

The new tool of medical research was built following a long period of study with the objectives of reducing the size and cost of very high voltage X-ray equipment, thus increasing its availabili ty to hospitals. The new apparatus can be produced and installed for far less cost, for example, than the well-known 800,000-volt units of 1933 which required a special building to house them and their vast array of supporting and contributing equipment. The 800,000-volt unit needed a building 62 feet long, 32 feet wide, and 36 feet high, and many tons of lead to protect operators and patients from the cumulative effects of X ravs.

The new equipment consists of a transformer of novel and radical design, together with an X-ray tube built of 11 sections. Transformer and tube are consistent of the consistency of two sections bolted together. The total weight, including 1000 pounds of lead for X-ray protection, is 4000 pounds.



Revealing the filament end of the tube and part of control mechanism



The outside steel shield (left) that encloses the tube and coils



Lowering the 100-coil transformer over the tall and slender X-ray tube

The transformer operates on threphase, 60-cycle power, and is designed to produce 1,000,000 volts peak at three milliamperes or more The tube is mounted vertically within the transformer in the space normally occupied by an uru occer. It is three and one half inches in diameter and 56 inches long The glass portion is completely shulded, electrostatically, for its entire length by the surrounding transformer.

The high tension winding of the transformer consists of more than 100 thin, flat coils of wire, built like huge pancakes with holes in their centers. These cakes with holes in their centers. These center passes the X-ray tube with the target end at the bottom and grounded, and the lot cathade filament at the top Completely enclosing the tube and couls is a steel shaded which, in effect, becomes the core of the transformer, although it so no the outside of the coils.

ANOTHER unusual feature of the equipment is that gas is employed as an insulating medium instead of the conventional oil. If oil were used in this unit, about 12,000 pounds would be needed, but only 100 pounds of gas (di-chlorodifluoromethane) perform the insulating function

There are no moving parts. The control of the unit is entirely electrical, and the enclosure of the million-volt circuit in a grounded metal tank eliminates the hazard of electrical shock.

Applications outside the medical field include its use in industry, such as for radiographic examination of large steel castings five inches and more in thickness.

Why the Earth's Magnetism?

MAN has known that the earth is a huge magnet almost as long as he has known anything about magnets. However, scientists have labored and speculated in vain for over 300 years since that discovery in the attempt to find a reason for its magnetism. Systematic and careful experiments have been made on a scale almost greater than any other scientific project. Special non-magnetic wooden ships have sailed the oceans charting the lines of force. Explorers have carried delicate instruments with them to out-of-the-way places to make careful magnetic meas-

DECL INATION 1920 1540 1800 1700 Figure 1. Secular variations of the earth's magnetism, as observed at London since 1540

urements. Numerous stations scattered over the earth's surface have watched

the hourly, daily, and yearly fluctuations for many years with extraordinary patience and precision

In the light of this extensive experi mental work, a recent paper in the Physical Review, official publication of the American Physical Society, will cause great interest among scientists the world over. This paper, entitled, "On the Origin of the Earth's Magnetic Field," by Dr. Walter M. Elsasser of the California Institute of Technology, has cast new light on this old problem and possibly pointed the way toward its ultimate solution

Early theories of the earth's magnetism were based on the assumption that the earth is a huge, permanently magnetized body Such theories would no doubt be very successful if it were not for one serious obstacle. The interior of the earth is very hot, being at least several thousand degrees centigrade, and all permanently magnetized bodies lose their magnetism when they become hot. The only alternative, then, is to say that the earth is a huge electromagnet, not a permanent magnet, and that the magnet-

The New Elsasser Theory . . . Radioactivity Heats Earth's Interior, Heat Sets up Eddies, Currents of Thermoelectricity Flow, Causing Magnetism

By C. W. SHEPPARD

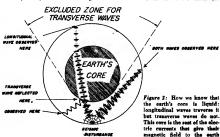
ism is caused by enormous electric currents. These are estimated to be in the neighborhood of a billion amperes. Measurements of the distribution of the lines of force over the earth's surface show that all but a few percent of these cur-

rents must flow in the earth's interior. The remainder can be accounted for by a ring of charged particles flowing around the earth somewhere between the stratosphere and the Moon. A fluctuation of the earth's magnetism in step with the 11-year period of the sunspot activity can be traced to this ring, whose charge dies slowly away only to be replenished by particles thrown from the Sun by the violent cruptions on its surface during the sunspot maxımıım

Although a description of the fluctuations of the earth's magnetism would fill many pages, its most important variations, from a theoretical standpoint, are the long-term, or secular, variations. Not only does the earth's magnetism change gradually over a few centuries under these variations, but also the north and south magnetic poles move around slowly (Figure 1). Any satisfactory theory of the carth's magnetism

must give a proper explanation of this phenomenon. The fact which makes scientists scratch their heads the hardest, however, is that, although the earth's magnetic poles are near the north and south geographic poles, they do not coincide exactly with these geographic poles. What can be the forces at work which make the earth's magnetism tend to be parallel with its axis of rotation and still allow it to deviate a small amount?

ALTHOUGH our information as to the nature of the carth's interior is somewhat meager, there are good reasons to believe that it is metallic. The most important information on the earth's interior is obtained from the behavior of earthquake waves. These waves are of two kinds, longitudinal and transverse. The longitudinal waves vibrate in the same direction as that in which they travel. Sound waves belong to this class. Transverse waves are those which vibrate in a direction at right angles to that in which they move. The waves one obtains on shaking the end of a rope are transverse. It is well known that liquids will not transmit transverse waves. Observations with seismographs at great distances from earthquake centers show that there is a large core in the center of the earth (its



boundary about 1950 miles below the surface) that does not transmit these transverse waves (Figure 2). Therefore, one can conceive of the earth as a large ball of molten metal with a thick crust of solid material floating on top just as alag floats on the surface of a melting too. It is in this easily conducting core that the electrical currents which keep the earth meantized must flow.

Attempts to explain this current as being due to galvanic effects such as produce the electrical energy in batteries have been unsuccessful, for the currents which could be produced in this way would be much too small Elsasser's theory finds a much better explanation in thermoelectric currents. Whenever two metals are joined together, there is a tendency for a current to flow from one to the other This tendency is propor tional to the temperature of the junction and depends on two quantities called the thermoelectric constants of the metals. Unfortunately, it is impossible to measure a current without making a closed circuit. Therefore, one must have at least two junctions Then, however, the tendency for currents to flow at one junction is just balanced by the reverse tendency at the other But, if the temperatures of the junctions are different the effects no longer neutralize and a current flows (Figure 3, top). This principle is used in thermocouples, which have a wide application in measuring high temperatures and in thermostatic control Suppose now that, instead of two strips of the two different metals, we take a large number of strips and join them

Figure 3: At the right is a thermoelectric pair. Below is a per-tion of a thermoelectric chain electric chain HOT JUNCTION COPER JUNCTIONS COPPER CURRENT COPPER JUNCTIONS ROON FROM

in a closed chain so that the two different kinds of metal with their different thermoelectric constants alternate (Figure 3, bottom). Now, if we keep alternate junctions at two different temperatures throughout the circuit, a current will flow in the same way as before where we had only two strips, but a larger one. If such a situation, or something nearly analogous, could arrise within the earth, a

large thermoelectric current would flow.

To cause such a systematic alternation of temperatures, the new theory supposes a source of heat at the center of the earth. Given such a source, a turbulent, boiling-up motion would occur. The velocity of the longitudinal waves trans-

mitted by the earth's core, with other information, shows that the interior is very plastic, being somewhat less viscous than ordinary pitch. Thus this boiling motion will be fairly rapid. For the necessary source of heat, small amounts of radioactive material in the earth's interior would be sufficient. This turbulence, or convection as it is called, is the same thing as can be seen in the air above a heater or in a saucepan on the stove This convection will break up into eddies which rotate about an axis pointing radially outward from the center, and the average motion will be in the direction of this axis. Thus at the centers of these eddies large quantities of hot material will be brought up from the interior and cause temperature variations. If then these temperature variations are coupled

with variations in the thermoelectric constants of the surrounding material, a resulting thermoelectric current will be set up.

The question as to how the thermo-

electric constants will change is hard to answer. The interior of the earth is at a pres sure of at least 10,000,000 pounds per square inch. The highest pressures obtained in the laboratory so far have been only one tenth of this and little hope exists that one can go higher, for the best materials available flow like wax under the stress. However, it is known that high pressure causes changes in the crystalline structure and in the relative composition of various components of alloys, and that these changes occur much more frequently than at low pressures. Since it 18 quite certain that the interior

of the earth is made up of several different metals, a large number of these changes may occur, and thus the thermoelectric constant will vary.

However, as it stands, the thermoelectric currents merely cancel out, as there has thus far been no determining factor as to whether they will go from east to west or vice versa. This is where the earth's rotation enters. Suppose a person sits on a piano stool and holds a weight in either hand at arm's length. If he is now set into motion, he will rotate slowly unless he draws the weights in, in which case, he will speed up Figure skaters make use of this principle in the pirouette At the beginning, they rotate

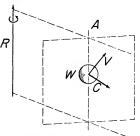


Figure 4. How the Coriolis force operates. The weight W moves in direction V. If whole system revolves around the sxis R in direction shown, W will appear to be under influence of a force in direction of C. Direction of C is perpendicular to plane containing A and V

slowly and spread out as much as possible. When they wish to speed up for the spectacular finish, they pull themselves inward. The force which causes this speeding up is known as the Coriolis Force. In general, it behaves in a very complicated manner, and cannot be adequately described without mathematics. However, the effect of it on the eddies inside the earth is to cause them to turn over slowly. Thus an eddy whose axis originally was radial gradually turns so that the axis points somewhat eastward. Actually, the description given here is a much simplified picture, and the real motion will be very complex and irregular. Nonetheless, in the random motion, there will always be the above-described tendencies. Meteorologists are very familiar with this force, since it causes the Trade Winds and the Gulf Stream. In this way, then, the Coriolis Force sets up an asymmetric effect (Figure 4) and a resulting thermoelectric current may flow.

Certain difficulties are present in the new theory. The greatest disadvantages lie in the imperfect knowledge now existing as to the nature of the earth's interior and the behavior of materials under the enormous pressures and temperatures known to exist there. All estimates of these things are extensions of knowledge obtained in a much lower range and are not likely to be particularly accurate when applied in this manner. But the new theory does provide a start on an old problem.

THE SALUKI EVERLASTING

ARCHING down through the ages comes man's love of hunting as a sport, and the pleasure he took in having about him some reminder of the companions of the chase. In a time when much attention is given to the preservation of trophies by taxidermy, the collection of hunting prints, and to bronze models of champions, ancient man is brought much closer to us when we find evidence of his similar devotion to his limiting dogs expressed in one of his earliest and most personal art forms Such were the engravings of his favorite Salukis hunting hounds on early stone stamp seals

These stone stamp seals were small, thick buttons or disks, sometimes with

knob handles, sometimes without, but almost always plerced so that they could be worn around the neck or attached to the belt by a cord through the piercing. On the flat side was cut some figure or figures which, when pressed into soft clay, left an unpression, just as our sealing-wax seals do today. These round, though sometimes square, impressions were men's signatures Later they appeared on clay tablets. Then the stamp seal developed into the cylinder seal which, when rolled across a soft surface, left in the clay an elaborate group of figures and still later carried even the crudely cut letters of the owner's name.

The seals of which impressions are allown at the right are from the joint excavations of the University Museum of Philadelphia and the American Schools of Oriental Research at the great city mound of Tepe Cawra in Northern Iraq near Mosul [Scientific American, Oct. and Dec., 1935 — Ed.]. They

come from Levels II and Mra and were found in house debra which is dated before 3500 s.c. The people who occupied the Vainted Pottery Peoples and they have left the stamp of their development in many parts of the Near East by their fine decorated pottery, and at Tepe Gawa by the advanced state of their architectural progress as well. Among the smaller things to play a part

Carvings Found in Ancient Ruins in the Near East Show That a Breed of Dogs Now Fashionable Among Fanciers was a Favorite there 5000 Years Ago

By W. H. NOBLE, Jr.

in their lives and which have come down to us, were stone gaming pieces, a pot tery holder of an obsidian razor blade (terminscent of our straight-edged razor), superb obsidian bowls showing a patience and technical attainment of high order in working in this stubborn material and, finally, a number of these

Modern drawings of some of the ancient seal impressions or personal "signatures" discussed in the text

small seals of which the impressions of only a few have been shown here.

Crude interpretations of the human figure, geometric designs, fish, and unidentifiable animals appear cut into the stone faces of the seels, but the one subject, and easily the favorite, in which they exhibit an impressive skill in portrature, is that of hunting dogs. These tall, slim, and uncommonly graceful animals do not present an easy task to the stone cutter, yet they are shown standing, seated, or in a playful attitude and you are definitely conscious that with early civilized man's technical ability went a great interest in and love of his subject. On the face of the seal on the opposite page —one of the best uncertied of the round swist—there are

as many as three of the dogs and with them are three animals, only one of which is easily identified, an ibex. Of another seal (right, center, in illustration on this page) only a portion of the face is preserved, and there we see the hunting Saluki with a smaller animal in front of him, poorly cut but with the small horus of the gazelle definitely protruding from its head The rectangular seal face in the same illustration presents a nice study in design, with the three dogs placed one above the other. Just what the objects are in front of them it is difficult to say; perhaps they are the heads of a two-horned animal, though these strange shapes may be merely "fillers," for we know that the purchaser wished to get his money's worth and insisted that the engraver fill up every open snace!

THERE is no denying the pride which these sportsmen of over 5000 years ago took in their sleek, graceful

hunting dogs, else they wouldn't have placed them so profusely on what must have been one of their fondest possessions—their stamp scals.

Strangely enough, today in the Near East, one of the Arab's greatest treasures is the same type of hunting dog—the Saluki. He does not, however, actually class his Saluki as a dog! If the modern Arab does not hate dogs, he ranks them very low in his estimation. Nor can he

be blamed, for the usual type of dog in Irak, Turkey, or in any part of the Near East is likely to be a ficrce, ungrateful and often cowardly beast-large, dirty, and untrustworthy. Partly, this is the Arab's own fault, due to his bad treatment and religious attitude toward dogs. The Saluki, on the other hand, is another matter He is more lithe and graceful than our greyhound, is larger and faster than our whippet and, above all, is very sensitive to human contacts. An American on one of the excavations in Irak wished to photograph a particularly beautiful example of the Saluki When asked to pose with his dog, the proud Arab master disdainfully refused, denying that it was a dog His insulted dignity could be soothed only when the American photographer obligingly agreed that this was in truth no dog, but an entirely different class of animal-a fleet and noble Saluki,

TODAY the Arab effendi saunters through the bazars with his heaut ful Saluki lieude him or smokes his water pipe in the coffee house with the lean animal stretched gracefully at his feet. At times he will even hestir himself to hunt the gazelle or the rabit. Then it is that the Saluki shows its greatest virtie, its marvelous speed With himsaster riding a horse at a gallop, the Saluki can be seen circling about him in great orbits with unbehevable swiftness, timing in mid-air with a leap when some prey is scented or else spotted with its keen eve.

The actual speed of these dogs is difficult to ascertain, though on Iraki roads one has been known to keep abreast of an American car when the speedometer read 42 miles an hour The driver of the car couldn't "step on it" any more Probably the Saluki could.

In the last few years American interest in these dogs has quite rightly increased by leaps and bounds. There is now an American Saluki Cluh, and at many of the leading dog shows on the Atlantic seaboard there are classes of Salukis. While their nedgrees are not



Ayesha, the modern Saluki mentioned in the text. She was brought to America by Mr. and Mrs. Charles Bache. Compare with the Salukis on the ancient seals

so old nor in such good order as some breeds, they have been accepted by the American Kennel Club.

The photograph reproduced above is of the famous Ayesha, brought to this country several years ago by Mr and Mrs. Charles Bache, of Philadelphia.



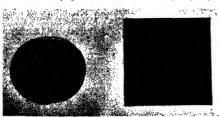
Stamp seals with pierced knobs for

who excavated many of the seals in Irak. Ayesha stands about 30 inches high and she thought nothing of leaping from the roof to the ground or, for that matter, of plunging through a plate glass door in a Beirut hotel, her knowledge of glass at that time being limited. She was entered with notable success in a number of shows in this country, though her par-

ticular kind was rare, being of a Koweit type. This principality is in Southern Irak on the Persian Gulf and breeds a somewhat more powerful animal.

As we follow the Saluki or his family history down from the Painted Pottery People, interest or cyidence of him is fairly slim. In Egypt, on the Old Kingdom reliefs in the Tomb of Tahotep, of the Fifth Dynasty, at Sakkara, we find an animal whose body is that of the Saluki, though the ears are slightly different Here a group is being held in leash by a servant who awaits their mater, while in another register they are shown attacking gazelles during a chase Persian miniatures show him delicately modeled and cream in color, accompanying his hejewelled and silken master. Morgan Stinemetz, in an excellent dog chart in Nature (February, 1939), reports that the Saluki first entered England in 1840 hut made little headway until imported from Arabia in 1895. After the Saluki's entrance into Russia in the middle of the 17th Century, "to slake a noble's thirst for fast dogs, was crossed with a collie-like native to provide the needed fur and so we have the Borzoi However, this example is a side shoot, not the main line of Saluki descent, and the latter is found in Arabia, not far from the earliest place of record 5000 years old

B UT it is back we must go to that mound of Tepe Gawra, which flow ished in the Land of the Two Rivers as long age as the 4th and 5th Millenna s. u. the standard of the Two Rivers as long age as the 4th and 5th Millenna s. u. they portraved them in their dags that they portraved them in their dags that they portraved them in their days them in their days the standard them is well that there is no dult about their descendants in the modern Saluk. These graceful animals bound and prance today. What of their masters?



The ancient seal at left does not look like anything in particular but its impression, shown at the right, reveals three Salukis and some other objects



MONTHLY DIGEST

Conducted by F. D. Mc H U G H

NEW X-RAY UNITS FOR FIGHTING CANCER

HIGH-VOLTAGE X ray machines of revolutionary design feature the equipment of the Memorial Hospital for the Treatment of Caucer and Allied Diseases, in New York City. Recently dedicated, the hospital uses for radio-therapy a 1,000,000-volt X-ray



Operating one of the easily ma-neuverable 250,000-volt X-ray machines. These are similar to the 1,000,000 volt unit described in more detail on page 151 of this issue

machine as well as five 250,000-volt units. Notable for their exceeding compactness and maneuverability, all were developed by General Electric through collaboration among research laboratory scientists, Memorial Hospital representatives, and G-E X-Ray Corporation engineers.

OUARTZ-LIKE GLASS

AN entirely new method of glass manu-facture yielding products which can be heated to cherry red heat and then plunged into ice water without breaking has been developed in the research laboratories of Corning Glass Works, it was announced recently by Amory Houghton, President. The Corning management made clear, however, that while the Research Department had completed its exploration into the unknown and had established its findings beyond doubt, it will be two years or more before the products can be offered to the public

The weirdest point about the new and revolutionary process is that articles made by it shrink to less than two thirds their original volume yet retain their identity

Contributing Editor ALEXANDER KLEMIN

charge, Daniel Guggenheim School of Aeronautics, New York University

and suffer no distortion of form. This means a linear shrinkage of 13 percent. For in stance, if you want to make a nine-inch dish you first make one ten and a half inches in diameter.

The new Corning process consists of a series of contrasting operations and there are several alternative variations at the end which give an amazing variety of results In simplest terms, what happens in the main process of this A normal glass object such



Above: Molten iron, poured on new glass chilled by ice, has no effect on it. Right: A 12-inch disk shrinks 11/2 inches during proce ing. The glass is 96 percent silica

as a plate or beaker is made by usual melting and molding operations but with a spe-cial glass formula. Then, through a series of treatments involving final leaching with of treatments involving man reasung was delute nitric acid, part of the atructure of the glass is removed—leaving a skeleton, so to speak. Then, under further heat treat-

ment, the glass shrinks down to a volume which is a reduction of 36 percent from its original size. As a matter of fact, during the acid treatment, 36 percent of the body of the glass has been removed, 64 percent remains The surface feels rough to the touch but does not feel porous Actually at this stage it is filled with sub-nucroscopic capillaries or air spaces. On final heat treatment the glass body reaches a transparent, homogeneous state in which it is practically 96 percent pure silica. In this completed state the glass can be heated to a bright cherry red color, and then dipped into a vat of ice water with no injury whatsoever.

The outstanding significance of the new Corning low-expansion glass is that it will offer in an economical price range a material similar to fused quartz. A miniature pilot plant has been operating for several months To put the process on a full-scale basis would require at least two years, even assuming rapid designing and building, according to the chemists in charge.

PERMANENT GLASS-MARKING INK

THEMISTS can make an effective and permanent glass-marking ink by mixing equal parts of chromic oxide with powdered lead borate, and stirring this into a mixture of equal parts of water, alcohol, and glycerin, according to Solvent News. The amount of liquid used depends on the consistency desired.

After applying the ink with a pen and allowing it to dry, the glass is warmed in the vellow flame of a Bunsen burner, then heated to red heat in a blue flame. The



glass is finally allowed to cool, using the yellow flame to lower the temperature gradually.

The ink is green, and because of the limitations of the process, cannot be used on heavy cast glass equipment such as desicrators, reagent bottles or the like.

TAXES

DURING 1938 gasoline taxes represented an average of 24.83 percent of all state tax burdens in the 48 states.

DESTROYER "HAMMANN" TYPIFIES NEW STEAM POWER ERA

Tille ghout of many a windyammer and the wraits of outmoded streamtips must have looked with envy upon the U.S. Hammonn, news member of the Navy'n Beet tell' and pranced efforties when teeth' and pranced efforties yet approximately 38 knots in her builder's trials receilly, manned by an expert crew supplied by her builder, the Federal Shipbuild ing and Drydeck Company, a subidiary of

the United States Steel Corporation Sleek and streamlined from her water-hine to her bridge, the Hammann demonstrated for a group of newspaper and magazine writers the efficiency, economy, and power of high temperature high-pressure steam that drives her livin sets of main propulsion turbiness Slie performed as re-which were authorized under the 1937-38 Naval Appropriations Act

The story of the Hammans is a story of power, for she is literally a \$5,500,000 power house aflost Compressed inside her needle-like hull is power enough to lift the 300,000-ton George Washington Meniorial Bridge more than 160 feet an hour-provided of course that the power of her two turbing units could be harmaged to such a lask.

units could be harnessed to such a task
It is the story of the transition of marine
power plant designing from empirical en-



U. S S. Hammann is an identical sister ship to the U. S. S. Anderson shown above

gineering with low-pressure, low-temperature steam engines to the scientific development of high-pressure, high-temperature turbines based on some 20 years of research. The result is production of destroyers that are the most economical and fastest fighting ships of their sire on the Seven Seas.

If yudged by appearances, the Hamman is a "little fellow" for a big job, she's only 341 feet long at the waterline, 36 feet in her actrume beam, and she weight as eant 1500 tones not much heaver than a gun turret on a modern builtedby. But encosed in her steel shell the ship earness a compact power plant that appeareds in performance the west of many of the largest high-pressure of many of built to opener in big city mover stations.

The six main turbines on the Hammann weigh altogether only 55 tons, but are capable of producing about 27,500,000 fost pounds of work per second

SMOOTHNESS INDICATOR

A DEVICE so sensitive that it will indicate the differences in thickness of a fingerprint on a piece of smooth glass, has been developed by J. A. Sams of the General Electric Works Laboratova.

Known as a surface indicator, the instrument is used to determine the smoothness of metal or painted surfaces and indicates minute variations far beyond the range of the human eye. Variations of as little as 171,000,000 of an inch are clearly indicated.

1/1,000,000 of an inch are clearly indicated.

By its application, the surfaces of hearings or other moving parts of motors and the like, that are subject to wear, may be tested and

their smoothness indicated

The apparatus appears somewhat like a
phonograph with its iturable on which is
placed the object to be tested, and its sapphire-pointed stylus or needle that passes
over the test material as it revolves.

Small mechanical impulses are created as the hard point rides over surface in regularities. These impulses are then transmitted to an electro-magnetic pickup which converts them into electrical impulses. They are then amplified and transmitted to a recording meter where the surface characteristics are graphically indicated.

The stylus or needle is so sensitive that when it is placed on the revolving metal turntable, the invisible obstations established by a person whistling are shown on the recording meter.

SOLVENT RESISTANT GLOVES

OR those who work with chemicals, and the sum of the su

THE LAW OF CONVEN-IENCE AND NECESSITY

MEMBERS of the Covil Aeronautics Authority, fere in number, have fame and montrous my more than and montrous have their toubles. Their all their also have their troubles. Their accessive for proposed auroutes. There is no longer a question of inducing a government department to establish mail service and then to grant a contract for that service on a hasis of competitive



Objects to be tested for surface smoothness are placed on the turntable



Eight years old, the Lieutenant de Vaisseau Paris is still in service

hidding, solcly, without regard to other considerations. Now, as Chairman Robert H Hinckley points out, much sounder methods are in vogue. He defines the granting of certificates for air routes in the following words. "The law applies the familiar doctrine of convenience and necessity Under that doctrine, in general, an applicant must show that in the territory to be served there is sufficient potential traffic to justify the service, and that the applicant is fit, willing, and able to perform it. We believe that th law requires proof that a proposed operation can eventually develop mail, passenger, and express revenue to the extent of assuring that the new line will not become a burden either upon the government or the community or the corporation proposing to operate it

A mass of new applications is even now before the Authority, with a gridron of a proposed new arlines. A tabulation of 48 applications from 24 different are services undicates that should all applications be granted, a total of almost 14,000 route miles would be added to the existing system of approximately \$5,000 miles. Nothing gives a better picture of the enormous scope of our train-port system— A K.

EQUIPMENT FOR SAFETY IN AIR TRANSPORT

WHEN people speak of aeronautical research they generally mean research
in aerodynamics, in the light properties and
structural siterath of the airplane, in greater
again reliability Certainly such research
is of innolumental importance, advantum reverted. But, as Paul Johnston, Editor of
southern, pointed out in a recent paper
presented at the Aeronautical Session of the
National Safety Council, there is another
type of re-search which is conducted by the
airline operators, individually or in co-operaion, which is not recondition practiced
by mathematicians or physiciats, but is of
copial importance as far as airline astery is

concerned
Thus, in conquering ice formation on the airplane, we find Goodrich continually improving its "over-shoes" or wing de-icers. Non-icing carbureters of the Chandler-Groves type are in service and being continually improved by the airlines. Wind-

shield wipers, with alcohol and other non freezing mixtures mechanically distributed over the windows, is another subject of investigation Improved fluids and methods for protecting the propeller against ice are now available

Radio developments are innumerable, and so well advertised that we need hardly touch upon them here. But there is a long list of other safety devices, some of them of humble character, which may not be as well known to our readers. Thus, upholstery and farm ture fabrics in the airplane are being fire proofed Birds have struck and broken windshields time and again; accordingly, wind shields are being reinforced. One transport company is testing bullet-proof glass for use in its windshields. The NACA, or venture engine cowls are being built of stainless steel to withstand corrosion and the effects of high temperatures Cockpits are being improved so that controls can never jam Hydraulic-pressure bench tests on engine cylinder heads are carried out to warn of possible failure. Metal particle detectors are inserted in engine lubrication lines, where such particles may cause serious damage. Bolts, nuts, and studs on plane or engine may be tightened up too much or too little; instead of relying on the skill of the nut into service.

The list could be continued. Any new safety idea is welcomed and investigated if it seems reasonable. Designers and inventors still have a fertile field ahead of them in airplane safety equipment -- A K.

FLYING BOATS HAVE LONGER LIVES

WE have read so much of the achievements of Pan American Arways, with the new Boeing Clipper, in establishing the first north Alantic are service, that it is hardly necessary to comment further on this historic subject. Less spectacular but also interesting is the recent flight of the French flying boat, Leutemant & Fusicous Paris, from Port Weshington, Long Island, to Biscaroses, France, in 34 hours and 14 minutes. There are two reasons why this hight is of interest. First, it is part of a series of survey flights being made by Air France. Eridently European companies will not leave the field solely to Americana. Second, the Vasseue Paris is eight years old, and is one of the largest flying boats in the world We used to think of aircraft as fragile vehicles, short lived due to depreciation or absolescence. The French boat has seen continuous service in various parts of the world, yet in cell, going among the control of the world, yet in cell going among the parts of the par

SODIUM LIGHTS FOR SAFER LANDINGS

W HEN fog and haze blanket an airport, flight operations may be emploid. Radio may bring the plot accarately to the airport, and a combination of radio and altimeter may bring him down 'bland' 'Still, the average plot would rather see in the last the average plot would rather see in the last time and the second of the second plot of the plot of the second bring
In this new lighting system, three green manulecent lights, placed flesh with the ground, indicate to the plot the beginning of the rainway Then, at 100-foot intervals, sodium contact lights of amber color, spaced on each side of the rainway, indicate that the plane is over the first 1000 feet or more of the rainway. The haal 3000 feet of the rainway as distinguished by white reasoning the boundary there are there more green



Inserting one of the sodium light-

lights Such oppositely placed lights mark

out the runway in aplendid fashion. Besudes the actual arrangement of the Bights in relation to the runway, two sid-vantages are claimed. The use of sodium lights increases visibility under foggy conditions. Field cess at Akron indicate that the sodium lights were visible at 410 feet, when incanedoesnel lights were only visible at 35 feet. Again, all the light emitted from the condition of the property of the condition of the property of the condition of the pilot's eye. A. K.

EXHAUST HEAT TO PREVENT ICING

TCE formation in flight still remains a serious problem, in spite of the strides that have been made in preventing it. A technical note of the National Advisory Committee for Aeronautics states that the Goodrich de-icer (which removes ice forcibly and mechanically from the leading edge of the wing) does not function satisfactorily under some conditions. It has been frequently suggested that exhaust heat from the engine might constitute a fine "anti-icer," and now experiments by the Committee indicate that the idea has possibilities
A model all-metal wing of six foot chord

was placed in a refrigerated wind tunnel, in which the temperature was kept at 20 degrees, Fahrenheit, and where a wind velocity of 80 miles per hour was available. Natural precipitation was simulated by admitting water to the air stream through a spray nozzle Electrically heated air was led through an air duct inside the wing. and a fan was used to circulate the air inside the wing

The results of the experiment, though preliminary in character, were satisfactory Ice formation was effectively prevented by maintaining a skin temperature of 200 degrees, Fahrenheit, over the leading 10 percent portion of the wing. The temperature in the duet varied from 360 to 834 degrees, Fahrenheit Heated air velocities in the duct varied between 45 and 152 feet per second

Similar conditions could be realized by leading exhaust gases from the engine through the actual wing of an airplane Let as liope that either the Committee or some venturesome engine constructor will carry out a similar experiment in actual flight

NO ORDER OF LESS THAN A MILLION DOLLARS

THE airplane industry flourished during the World War, almost perished of inanttion after the armistice, had a boom period in 1929 or thereabouts, and then again fell on very bad times Now all airplane manufacturers, particularly those building military and naval aircraft are flourishing and receiving large orders. It is being said jokingly in the industry that no order under a million dollars will be accepted. For example, Curtiss-Wright in its Buffalo airplane division received recently an order of \$12,-872,398 for a large number of P-40 pursuit

planes, an example of which is shown in one of our illustrations. Some noteworthy items appear in the photograph. The liquid cooled engine is evidently coming into its own; the familiar radial has disappeared in this ship. Oxygen equipment permits long flights in the sub-stratosphere. Fillets between wings and fuselage are very large. The vertical tail surfaces are disposed below and shove the stabilizer, as a precaution sgainst spinning. The Pitot tube for the airspeed indicator is placed toward the tip of the wing and well shead so as to be free of interference. The cockpit has perfect visibility All performance figures are withheld, but it is quite clear that our designers are producing excellent military aircraft.

- A. K.

PETROLEUM

THE fields of Texas, California, and Oklahoma alone have pro-duced more oil to date than have all the fields in Russia.

LIOUID COAL

DRIVES A CAR

EXHIBITING the startling possibilities of their newest development, liquid coal, scientists of the Research Foundation of Armour Institute of Technology recently showed how it was possible to operate and drive a 1939 stock model automobile, a Pontiac, on coal This newest development in research is credited to Dr Francis W Godwin, Director of the Coul Research Division of the Foundation.

The most amazing part of the entire demoustration is found in the fact that the test with coal was made on a standard car engine without any changes of any kind in carburetion or in the ignition system of the motor, with the exception of the removal of

one fine-screen filter According to Dr Godwin, three different types of colloidal fuel have been used suc cessfully in the tests on the stock model automobile to date. The first of these fuels was a suspension of a specially prepared coal, ground to 300 mesh, in a mixture of gasoline, fuel oll, and lubricating oil. The

second test with the "liquid coal" was made with a suspension of the coal in a Diesel oil. The third test was made with a suspension of the coal in a very light oil. The more recent test and demonstration was carried out with a more elaborate preparation of the fuel A very light oil, or a form of range oil with a light fraction of hydrocarhous, was used as the vehicle, followed by special treatment with the coal, resulting in the suspension of coal of about 500 mesh



Stoking liquid coal in a motor car

In each case, before the liquid coal was introduced into the auxiliary fuel tank on the automobile, it was chemically stabilized in order to hold the coal in suspension

After the liquid coal had been prepared according to the process developed by the scientists, it was introduced outo the anxilsary fuel tank. The automobile was then started on gasoline and, after spooth running conditions had been attained and the motor had "come up to driving heat," the fuel system was changed so that the gaso hae supply was cut off and the liquid coal introduced in the carbureter. Thereafter the engine ran on bound coal, and the ear

ran without undue strain or sluggisliness. Although liquid coal is not a product that is ready for the market or, more specifically, ready for consumer use in automobiles, the possibilities as shown by the demonstration are important Especially is this fuel deairable for the home owner who has been concerned with the problem of heating. It was pointed out that this fuel has been used in many types of domestic and commercial oil burners during its development, and that the heat value per cubic foot, as proved by these tests, is considerably more than either coal or oil alone. It was pointed out that the new fuel will make use of the tremendous amount of "fines" which are at present a waste product at the mones a waste product which the coal producers often cannot even give away

BRILLIANT BLUE

OPPER phthalocyanine, one of a new a group of synthetic dyes and pigments which was recently described by M Dahlen, of E 1 du Pont de Nemours and Company, is a blue dye of remarkable brilhance, tinctorial strength, and fastness lt is replacing iron blues and various basic color lakes in printing tilks, and ultramarines in paints, lacquers, and enamels. It is also being used in producing costed and printed textiles, coated paper, colored hnoleum, and in rubber to produce any shade from deep reddish blue to greenish pastel.

One difficult problem solved by the pigment was the provision of a suitable blue



\$12,872,398 worth of these P-40 pursuit planes have been ordered

is easy to nibble and has a pleasant oily flavor, and includes the following seeds: coconuts, Brazil nuts, almonds, cashews, pis-

tachio nuts, pili nuts, paradise nuts, pine nuts, pumpkin seeds, water-lily seeds, sunflower seeds, and the versatile peanut The pecan nut, produced as a \$6,000,000 per year orchard crop in Georgia and from native trees in the Southwest, is being grown in such quantities that new uses are being sought, particularly for imperfect kernels. Recently, Professor T. H. head, of the University of Georgia reported to the American Chemical Society what is known of this nut, and suggested industrial uses for its component parts Pecan oil has a bland odor and taste, and, having marked stability against oxidation and even aunlight, has been suggested for use as a salad oil and in cosmetics. Delicious cookies and cakes were made from a base of flour and

pecan meal, from which the oil has been



Above and below. Two views of the rotary fish screens in the Yakima River, described below, in which paddle wheels turn the cylindrical barrier screens

for three-color printing. Another application is in the production of an exterior paint. The new paint does not have the tendency of previous blue-tinted paints to fade quickly when exposed to suplight

ROTARY FISH SCREENS GUARD YOUNG SALMON

W ORK was completed recently on what thorities to be the largest batter of rotary fish screens in the world, installed across Wapsto dich at Parker, near Yakima. WPA's participation in the project involved supplying the labor, for which \$35,400 in Federal work relief allocations were invested.

These screens were designed to prevent young salmon, en route from headwaters of the Yakima River to the Pacific Ocean, which find their way into the huge ditch, from going into the irrigation laterals to destruction.

A battery of ten cylindrical screens spans the entire width as a barrier in the dutch. Each screen is 12 feet long and 13 feet in diameter. The flow of water in the dutch turns separate paddle wheels directly connected to each cylinder. Continuous turning prevents the screen from being clogged with mud and debths. By-pass channels lead from a bank of the canal, just above the screens, back to the river, to allow the altimon finger-

lings to continue their journey to the ocean. United States Bureau of Fisheries experts and other fish authorities state that the general instinct of the salmon is to return to spawn as an adult to the stream of its origin. The Indians foresee even a more happy fishing ground than in generations past, as a result of the fish screens.

RUB-LESS METAL

CLEANER

A NEW metal cleaner that instantly removes, by chemical action, stains and
oxides from chromium, copper, braas, silver,
and other metals, has been announced by
Rapid Electro-plating Process, Inc., to be
sold under the name of "1-Second" Metal
Cleaner. It is applied with a brush and immediately waped off, no rubbong is required

The new liquid cleans hard-to-reach places, does not soil hands, and has no



offensive odor It is said to contain no caustic; is non-inflammable, will not etch or harm metals; has three to five times the covering power of ordinary polishes, and, since it can be applied with a brush, will clean surfaces inaccessible to hand-rubbing methods.

The cleaner can be supplied either with or without abrasive and is designed not only for use in public buildings, households, and automobiles, but also for industrial operations where it is possible to wipe off excess cleaner after application.

BREATH

THE average human being exhales three pounds of carbon dioxide gas per day. To break down this exhaled gas and return oxygen to the atmosphere three large trees are required.

Nurs

A NUT is an "indehiacent, polycarpellary one-aceded fruit with a woody pericarp, developing from a syncarpous ovary." The acorn, hazelaut, and chestnut are true nuts, as are walnuts, pecans, hickory nuts, butternuts, and becchauts. But by more popular definition, a nut is any hard-shelled seed that contains a kernel that pecan breakfast cereal appears to be under

Industrial use of the pecan is predicated on the success of a new floatson method of separating the kernels from the shells of the cracked nuts, by agitating the mass vagorously in a salt brine, after which the kernels float and the shells ank. This may reconstitute the shell of the cracked nuts the shell sank. This may inchanize an industry hintero peculiarly dependent upon chesp hand labor. Unformately, the method recently developed in California for automatically cracking analust by miniature explosions cannot be applied to pecans. It will be recalled that in this method of a mixture of accession cannot be applied to pecans. It will be recalled that in this method of a mixture of accession cannot be applied to pecans. It will be recalled that the method that the subject of the state o

The per capita consumption of peanut is about sight pounds pract in the state of the control of

butternut, are not commercially significant, but are the property of the small boys of the land.

New nuts are added from time to time Out of exotic Hawaii now come limited quantities of the macadamia nut, a delicacy to tempt the palate of the epicure. Cashew nuts were introduced into America not many years ago by an enterprising and imaginative food chemist, who found them in wide use in India. The cashew is a relative of the poison ivy and Japanese lacquer plants, and parts of the cashew plant, if touched, would poison most people, yet the nut kernel, after being Frenchfried in hot fat, is a delicious tidbit, notable for its tenderness and sweetness. While at present the cashew nut is being exploited almost entirely as an edible nut (30,000.-000 pounds per year of the kernels are consumed), the shell contains a substance which may eventually become more important industrially than the kernel itself. This substance is a resinous liquid which, when chemically treated, forms products which are of marked utility in the plastics industry

The almond is practically a soft-shriled procedu-sion that has a pleasing high-proton kernel. Few other must have more than 10 or 15 percent of proteins, but contain from 40 to 75 percent of fast and small amounts of starch and sugar. Pecan means are the richest in fat of all nut meats, with Parill nuts, filters, and waluts not far hard and the are a highly concentrated food, and was a highly concentrated food, and contains the contains a support of the contains the contains a support of the contains the co

The coconut tree is credited with being by far the most valuable of all the food trees of the world, and is of vital importance in the tropics. The prosperity of the South Sea Islands rises and falls with the demand for copra, or dried ecconut meat, which is the source of coconut oil This oil is used in immense quantities for soapmaking and in oleomargarine, and the residue is valuable concentrated cattle food Because of excise taxes placed on such oilbearing nuts as the coconut and palm kernel, other nuts with strange names are finding a large North American market. In this group are the babassu nut, the colume nut, tucum nut, ourscury nut, and the murumuru nut, all South American.-The Industrial Bulletin of Arthur D. Little, Inc.

WOOL

TWENTY-five million pounds of wool, the product of 3,000,000 sheep, are consumed by the automobile industry in an average year.

DIGESTIBILITY OF

STRAW

STRAW contains large quantities of carbohydrates which can be only partially digested by farm animals. Various attempts have been made to increase the digestibility of straw by some pre-treatment.

In the course of an investigation of the problem, oat- and wheat-straw were treated with caustic-soda solutions of varying strengths and for varying largets of

Heat results were obtained with a 1.25 percent solution and an immersion period of 20 to 24 hours without heating. With

BURIED TREASURE FOR THE 70TH CENTURY



by Westinghouse

Many people have asked us how the Westinghouse World's Fair Time Capsule came into existence. Why should an electrical company be so interested in what the people of 5,000 years hence think of us?

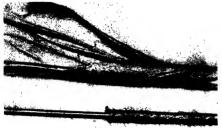
It all started with the slogan of the New York World's Fair. Most people, we knew, were thinking of "The World of Tomorrow" in terms of ten or more years. Why not, somebody suggested, take a real leap into the future?

Groups of scientists, to whom we appealed for advice, applauded the idea of preserving something for the future; said it was too bad the Egyptians, and the Sumerians, and the Mayas hadn't been as thoughtful. Librarians, printers, historians and others helped with suggestions for the Book of Record of the Time Capsule, which is expected to preserve the story of the Time Capsule, which is expected to preserve the story of the Time Capsule for future generations. A committee of engineers decided that one of the newest allows, Cupaloy, could be counted on to resist corrosion, pressure and other hazards for many thousands of years. By using the latest techniques, such as microfilm, we were able to cram an astonishing lot of information, and several hundred articles and materials of common use, into the Time Capsule.

Through it all, we had the help and enthusiasm of many of the country's foremost scholars and scientific men. In fact, it was an illuminating experience to learn how pleasantly men and women in all walks of life can cooperate in the working out of a simple, uncommercial, imagination-provoking idea. It was an emotional experience, too. On the day when the Time Capsule began its long rest, at the site of what is now the Westinghouse Building at the New York World's Fair, more than one person in the audience wiped tears from his eyes when the glistening Cupaloy Capsule began its solemn descent.

But what's the nub of it? Well, we think the Time Capsule attracted such wide and kindly interest because it is a sort of symbol of our age; an age of which most of us are intensely proud in spite of many difficulties and shortcomings. An age that not only believes it has something of great value to preserve and pass on to the future, but equally significant, one that knows how to preserve it—at least the material part of it.

We hope the "futurians" do find the capsule, of course. If they are so far advanced that the objects we have left seem only toys to them, we think they will nevertheless be interested to know that an age otherwise pretty intent on its own problems, still found time to think of the future.



Old and New: Spiral paper (top) and new molded pulp wire insulation

the volume of solution used, this represent ed 10 pounds of caustic soda per 100 poundof straw The starch equivalent per 100 pounds of straw was more than doubled by the treatment

Treated oat-straw fed to fattening bullocks resulted in a daily livestock gain of just under two pounds over a period of 62 days .- Nature

MOLDED PAPER INSULATION

T ISING a new process of producing paper insulation on a telephone wire instead of wrapping it around afterward, engineers of the Western Electric Company have just created a cable containing 4242 separately insulated copper wires

The previous top in wire packing was 3636 wires to a cable 2% inches in diameter The new cable is no larger but contains 606

The heart of the new development is a process for forming paper pulp directly on groups of 60 wires passing through a bath of pulp These strands are twisted two wires to a pair and assembled into the cable which finally is dried out in vacuum ovens

The saving in insulation thickness per wire is only three one thousandths of an inch but when repeated 3636 times in a single cable it results in 100m for 606 more-Science Service

ASPHALT ALUMINUM

PAINT

ASPIIALT, tung oil, and aluminum paste have been combined in a recently announced paint which is said to be suitable for either inside or outside application. The paint comes ready mixed and may be ap plied direct from the container

INDUSTRIAL PUMP MADE OF GLASS

HANDLING of commercial quantities of corrosive acids and chemical fluids has long been one of the most difficult problems of the chemical engineer. Many of these fluids quickly destroy metal pipes and pumps, and thus make some processes costly Also, minute traces of corrosion impurities may completely change chemical reactions and hence the resulting product Pipes of glass have for many years solved the problem of conveying corrosive liquids, and now a pump of glass, perfected by Corning Glass Works, marks a further step in the safe and economical handling of such liquids

This new pump is of the centrifugal type Not only the casing, but also the rotating impeller, and all parts in contact with the corrosive liquid are of clear, clicmical-resistant glass. The rotor is accurately bul unced, and, running at high speed without appreciable vibration, the pump readily handles 6000 gallons of acid or other liquid per hour and will deliver it 70 feet above the suction level

Neither boiling temperature nor strong



Above: Glass casing, impeller, and back plate of the new industrial pump. Below: The pump assembled with direct-coupled driving motor

acids affect the glass of which this pump is made. The problem of pumping hot hydro-chloric scid can thus be solved economically for the first time

So clear is the glass used that the interior of the punip may be watched while it is in operation. Should cleaning be required. the whole interior of the pump can be laid open in a few minutes. All acid solutions (except hydrofluoric or glacial phosphoric acids) may be used without fear of pitting or injuring the hard chemical Pyrex brand glass surface Reassembly after cleaning is quickly accomplished and the proper adinstruction of parts is practically automatic

STOP, LOOK, LISTEN

APPROXIMATELY 35 percent of accidents at highway-railroad grade crossings during 1938 resulted from operators of motor vehicles crashing into the sides of trains.

CLAY FILM

SUBSTITUTES FOR MICA

DEVELOPMENT from common clay of a film which looks like celluloid or Cellophane and which can be stored in water for an indefinite time without de retiorating, was announced recently at the Sixteenth Calloid Symposium of the American Chemical Society, at Stanford University, by Professor Ernst A llauser of Massachusetts Institute of Technology and Miss D S le Beau of the Dewey and Almy Company.

In sheet form, the new material, Profes sor llauser declared, promises to supplant sheet mica, a strategic military material, important in insulation, which the United States has to import from foreign countries in thousands of tons annually.

The water-resistant quality of the new film is the result of research just completed, Professor Hauser said The first self-supporting, coherent sheets made from pure clay about a year ago swelled and finally disintegrated in water Called "alsifilm." the material nevertheless had many "amazing" qualities, according to the chemists. Being entirely composed of inorganic matter, it was non-inflammable and would stand extremely high temperature without de-



organic solvents in general, as it basically contained aluminum or magnessum silicates. In dry condition, it exhibited very satisfactory electric unsulation properties, which, however, dropped rapidly as soon as the film picked up traces of moisture.

The new water-resistant film overcomes this drawback and retains all of the good qualities of the first clay film. Both in regard to its general properties and its actual composition, the material, Professor Hauser pointed out, is comparable with miea.

The alsifilm can be produced in any desired size and thickness and can be made decidedly more flexible than natural mica

RAILROAD TRUCKS

AMERICAN railroads have 53,000 motor trucks in terminal transfer, inter-cut, and store-door delivery service. This number of trucks exceeds the number of locomotives operated by the railroads.

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The machine, briefly, is a ware recording and reproducing unit a bala and compact and reproducing unit a bala and compact and reproducing unit a bala and compact and records a 780 on a collar of Cellophane-like material which costs five certs and as on line that three of them (containing about 25,000 words) can be folded into an exvelope and mailed for a three-cent stamp. A supplementary device makes are also a containing about 25,000 words) can be folded in a containing about 25,000 words) can be folded to a containing about 25,000 words) can be folded to the containing about 25,000 words) and the containing a containing

These records last indefinitely and may be folded flat and filed, to be played when needed. Or they may be transcribed onto typewritten pages by a stenographer using either loudspeaker or headphones.

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The Cellophanelike collar upon whell
the sound is recorded is only three onethousandhis of an inch thick, but a strong
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renders it as readily foldable as paper while
reating a toughness like that of silk. Withmay be immediately played back, or "read"
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Since the machine will record ordinary conversational tones within a radius of 20 feet, it is possible to record a business conference or discussion participated in by a roomful of men.

At newspaper offices, with the personnel busy, the meal-time may be hooked up to the telephone to take down stories phoned in the telephone to take down stories phoned in by reporters, saving the stongrapher and obtaining an error-proof record. In hosting the person of the person o

GERMICIDE PROTECTS SPORTING EQUIPMENT

THE problem of sterilizing and deodorising sporting equipment long has troubled proprietors of skating rinks, gymnasia, and swimming pools. Taking a tip from the WPA., many now are using Wyandotte

Steri-Chlor, an effective germicidal agent

that may be applied in powder or liquid form.

Experience of the federal government has proved that this product is excellent for dismiceting boots that are worn by many workers. A half-teaspoonful, sprinkled inside each shoe, retards the spread of athlete's foot and amiler diseases

The product is stable and will maintain uniform strength. When used in solution, its low temperatures, providing the highest degree of sanitation.

Because it harms only germs, it is widely used in sterilizing fountain and dairy equipprotecting all types of sporting goods.

PLASTIC COMPOUND FROM

SUGARCANE BAGASSE

A PLASTIC compound made from the asso, one of the country's important agricultural waste products, has been manufactured by chemists of the United States Department of Agriculture at the Agricultural By Products Laboratory, Ames, Iowa. The chemists estimate that this new compound



Sugarcane bagasse plastic may be molded in a wide variety of forms

can be manufactured for less than half the cost of the cheapest synthetic plastic compound now on the market.

Molding compounds may be made from the bagasse by three methods The first, and cheapest, is hydrolysis with acid. Counting the cost of bagasse at eight dollars a ton, baled and delivered at the factory, the chemists estimate that a plastic compound can be made by this method, in which the cost of material will be slightly more than two cents a pound. Plastics made from the compound, while not so strong as some synthetic products now in use, are quite moisture resistant and would be suitable for molding bathroom tile for both floors and walls. They apparently have the wearing ability of wood and may be sanded and re-polished through the entire body.

The second method is hydrolysis in the presence of aniline, a coal tar derivative. The material cost of plastics from this process will be more—about 41/2 cents a pound but they are as strong as plastics now in use. In tests it has resisted bending pressures up to 9000 pounds per square inch. They are slightly less water-resistant than plastics made by the first method, but do not warp

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and may be sawed, drilled, and, with care, nailed. These properties suggest uses as card table tops, desk tops, and building panels

Treating the bagasse with sodium hydroxide and furfural is the third process. In quality, plastics from this method are about midway between the other two. They flow better and mold at 2500 pounds per square inch compared with 3500 for the second treatment. They may be put to the asame uses as the plastic from the second treatment.

Either of the plastics made from the last two processes do not shatter easily. In fact, neither breaks when struck hard enough with a hammer to cause a dent.

It is possible that other farm waste materials, such as cornitalis and straw from small grains, may be used in making plastics by the same processes, the chemists report.

TOLL

DURING 1938 in the United States there was one accidental death every 5½ minutes. Non-fatal injuries suffered in accidents occurred one every 3 seconds.

JUDICIOUS JIGGLES

VIBRATION to like a surious areak in that it can be one man's near tor another man's posson. Many engineers are troubled with machines that shake too much, others are spending their best effects. in building mechanisms for the sole purpose of creating whration, but vibration whose intensity and frequency are under continuous countrol. There are numerous points in industry, notably in the fields of construction, mining, chemical processing, jugging or even wever shaking as a necessity, declares the Industrial Buildean of Arthur D. Lattle, lace

When the thing goods are electrically operated, the source of power is generally a magnet, for it lends useff to mechanism which are simple in construction, with few oling points, and with correspondingly few points to wear or cause trouble. The rug-gedness of such tools is indicated by the fact that a large outlet for them as in ham-less than the control of the control of the district in th

The conveyor line is a frequent user of magnetically induced vibrations. Not only will relatively tractable materials like said move amouthly down a properly oscillated trough, but also obdurate objects such as dig biscusts or metallic fasteners which, under ordinary conditions, may not "flow" at all. Although the eye seen only a uniform progression, the goods are actually jumps. (The dog biscustor—and articles less than the progression of the pr

By means of a rhoostat, the rate of feeding can be varied from, say, 10 tons per hour, as in one application in a smelling plant, to a slow dribble. Vibrating conveyor feeders are particularly useful in conjunction with automatic weighing devices, because the close control possible allows an operator to feed rapidly until the scale beam trips, then to stop the flow of material instantly In spite of the wide use of magnets in other fields and the accumulation of much empirical data, there are no comprehenave formulas which permit the ready calculation of optimum dimensions for a given condition. Experience during the past decade, therefore, has led to steady improvement in details and to the exertion of progressively greater forces for the same movement of the magnet armstore. A more basic improvement has been the application of "power pulses" to energize the magnets Engineers attempting to avoid of power through their apparatus, builderof electromagnetic vibrators want, and have obtained, power that comes in spurt-The simplest way to supply the magnets with oversized "quantums" of energy sep arated by periods of no current flow is to ase so-called half wave received alternating current (produced by passing alternating current through some electrical valve that sllows current moving only in one direction to pass through it)

A recent and important advance is the use of pidese created by condense discharges, a method that allows great flexibility in the frequency at which the pidesare supplied. Dividopments in large capacity let frome tides permit the original source of power to be either alternating or direct current, and in this manner make control of the condenser discharges commer cully feasible.

The resperimenent of print makes the prediction of applications for this increased versatility a dange core-pastine, but magnetic and mining industries. Electrically wheat of series have been found particularly resistant to "blinding" or wedging of the material between the wires

Vibration is necessary in making pulp fibers mat into a sheet of paper, it is also being used in the placing of concrete. Satisfactory consolidation can be obtained with lower water-cement ratios than is practicable with hand-placed mixes, and physical properties are correspondingly better Artificially induced vibration has even proved to be a valuable means of testing laboratory specimens and completed structures such as bridges, buildings, and water tank towers. Oscillators are attached to the structure, and measurements are made of energy input and the degree of dampening. From the readings can be deduced such dynamic properties as endurance limits, periods of resonance, and the existence of structural defects.

In these cases, as in most others wherevibrations are deliberately created, no random shakes will do, but it is necessary to provide oscillations which can be adjusted to meet variations in the conditions or to give optimum results.

COPPER-BEARING CEMENT

A COPPER-BEARING cement, recently announced, appears to have possibilities of great usefulness in making "composition" floors, stucoe, and mortar for tiles and glass brick, reports Highway Research Abstracts.

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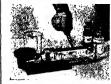


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Provision may he made also for "selective calling." A host so equipped is assigned a number, and its equipment maintains a contunuous, silent watch, to receive only calls that may be directed to it. When the shore station operator dials its number, a telephone bell rings exactly as on land.

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The device may be operated from a six of twelve will hattery or it may be simply adjusted for use with other voltages. The insamitter operates on any one of four crystal-controlled frequencies. By merely changing the quartir plates, frequencies other than those originally selected for the transmitter may be substituted, within the range matter may be substituted, within the range matter may be substituted, within the range unent is required when making the change. The receiver, too, may be crystal-controlled if desared, which eliminates the inconvenence of "shaling" for inconing calls.

Specially trained personnel is not required to operate the equipment. The regulations of the Federal Communications Commussion of the Federal Communications Commussion permit the operation of radio telephone equipment in manne service by persons holding a third class radio telephone operator's itemse which calls only for an elementary knowledge of the radio laws and regulations, and familiarity with the method of operating the equipment.

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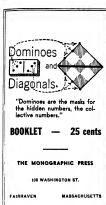
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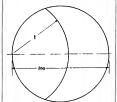
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rope be it the cow is to be allowed to graze one half the area of the field?

This problem is offered by Lieutenant Commander Leonard Kaplan, United States Navy, to readers who enjoy wrestling with things mathematical No prize is offered for its solution. The correct answer is 115.87 feet but the solution-which is the part having chief interest to the mathemati cian-will be published in this department next mouth

Lieutenant Commander Kaplan was the author of five problems offered in our April. 1939, number, page 219 The answers were given in the same number, on page 251, but the solutions were not published hecause they were so long. The solution to the above problem is not so long and will be published In the meantime, please address all correspondence regarding this problem to Lieutenant-Commander Leonard Kaplan, in care of Scientific American, 24 West 40 51. New York, N Y, and it will be forwarded unopened.

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KID PICTURES

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So take your kid pictures when, as, and of the opportunity occurs for unusual shots.



"Gee"

Move close for pictures of children in order to reveal their childish expressions. Avoid contrasty or low-key lighting as much as possible. Don't worry about freckles or lost teeth, but make the most of them. Get them candid wise or let them pose themselves naturally, in the latter case perhaps aided by a hint or two from you. Babies will give no trouble in this regard because they don't know what you're about anyway. Don't spare film when the kid shooting

16 good. Although occasionally you will get just the right expression and pose the very first try, the chances are that you will have to take several in order to afford a selection later on. Any camera will serve the purpose and the use of the enlarging



"Little Miss Homebody"

process will make up for any lack of ability to come closer with your particular lens equipment. Where it is found desirable. some diffusion under the enlarger will frequently help to improve the result by softening sharp outlines. Watch out for good backgrounds when you can, but since you cannot always choose, it may sometimes be necessary to shoot against a disturbing background or not to shoot at all. Such a picture as "Gee!", for example, either had to be made as it was or be lost altogether. Illustrating this piece are a few pictures of children made on different occasions.





"Hi, there!" was one of those impromptii things that make the photographer's life a happy one. While we were idling with the camera towards the end of a busy picme day, a mother and her baby, friends of our group, came along to join us. As they reclined on the grass conveniently only a few feet away from the camera, we shot head on from ground level just as the baby was exchanging smiles with someone standing back of us. The pose of the mother's with the animation expressed in both faces. seemed made to order.

A week-end visit with friends produced "Little Miss Homebody." One of the secret objectives of the trip was to make a picture of the little daughter of the couple we were visiting, but she was an extremely active child and we had almost despaired. Finally, just as we were about to leave on a few hours' auto jaunt into the country, she sat down in a big chair by a window There was not much light coming in, but opportunity was knocking and we had to make



"Pale"

the best of things Setting the eamers on the window sill to steady it and asking the subject to hold still "for a second" we hararded a shot at 1/5 of a second, //3.5 lens opening. The negative showed the hands sharp, but the bead had moved slightly. The expression and the pose were so charming it seemed a pity to lose the picture just because of a little movement of the head The solution came in the use of a diffusion lens during enlargement. This effected the desired compromise between the sharp hands and the "soft" face definition, besides affording a pleasant and desirable atmospheric effect.

"Suste" was also enlarged by diffusion. this time in order to minimize the harshness of the high-lighting as well as to assist in reproducing the mood of the subject at the time the picture was made.

"Gee!" was another picnic shot and was ne of a group we shot "from ambush." The boy knew the camera was present but appeared to ignore it. At the particular moment this picture was made, he was listening wide-eyed to the sound of an air-plane passing by. The person sitting by him moved back quickly so that while the background is somewhat cluttered up, the boy's face and figure predominate. If there were more lessure time than we have at the moment, the paper negative process could be profitably employed in removing most of the objectionable background

"Pals" was shot against the clouds from an extremely low position. More of the figures was included than shown in the picture, but cropping under the enlarger enhanced the effect by bringing the faces into greater prominence.

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RULES of the Contest

- t The groups will be judged independently on the basis of pictorial appeal and technical excellence The decision of the judges will be final In case of a tis for any prize, duplicate prizes will be awarded to the tying contestants
- 2 Prints must not be smaller than 5 by 7 or larger than ii by 14 Prints need not be mounted, but may be st the contestant's option
- Photographs must be packed properly to protect them during transportation
- 4 Non-winning entries will be returned only if sufficient postage is included when the prints are submitted
- 5 Each entry must have the following data written on the back of the print or mount Name and address of contestant, type of camera, and film enlarger and namer used
- 5. Contestants may submit no more than two prints in each group, but may enter any or all groups
- enter any or all groups

 T. Prints must be in black and white
 Color photographs are not eligible
- 5. Prize-winning photographs will become the property of Scientific American, to be used in any manner at the discretion of the publisher
- 9 Scientific American reserves the right to purchase, at regular rates, any non-winning entry
- 18 No entries will be considered from professional photographers
- professional photographers

 e 11 All entries in this contest must be
- in the hands of the judges by December 1, 1939 Results will be announced in our issue dated February 1940 e 12 This content is open to all amateur
- It This context is open to all amateur protographers who are not in the employ of Scientific American

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Awards

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THE JUDGES:

McClelland Barclay, artist ivan Dmitri, artist end photographer Robert Yarnali Richie, commercial photographer

medium filter is still the most useful and the most convenient for the purpose. All we have to do is double the exposure or open the lens diaphragm one stop larger than would normally be required without the filter. But a deep yellow filter, requiring only three times the exposure, when using panchromatic film, or an orange, requiring about four times, or a red, calling for six to eight times normal exposure, will provide more dramatic sky backgrounds, though at the cost of over-correction. The disadvantage of using these contrast filters is the relatively long exposure required, but in these days of very fast film emulsions, anapshot exposures may be had even when using red filters.

FOR THE NATURALIST

Wilatr's wrong with this picture of snake's eggs? One person tells us the eggs look very large when as a matter of fact they were quite small, roughly a little inder 2 inches in length. Some fa-



"Snake's Eggs"

milar object, preferably a pocket ruler, should have been placed slongsade one of the eggs to indicate its true saze, or a human hand might have been included in the view, picking up one of the eggs or holding it in the palm. The picture was a snapshot at close range, employing a supplementary lens.

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"Ballyhoo"

made by day because of the more interesting lighting. Fast pan film should he used Exposures at 1/25, 1/50, and even 1/100, depending on the lens speed, are sufficient to record all necessary detail Move in towards the front of the crowd in order to avoid obstructions and to get a clear view of the subject

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CAMERA CROSS ROADS OF THE WORLD

how the camera is operated before we start using it. This department would like to suggest that manufacturers and distributors issue two sets of instructions, one extremely brief and giving only the bare essentials necessary for operating the camera, the other more extended and detailed. The brief one would be for use in the first moments of possession of a new camera and would be written in monosyllabic language, just as one would give instruction to a child. Best of all, the dealer should load the camera for the purchaser, set the distance and stop for fixed focus operation, instruct the user to shoot only in broad daylight, and show him where the release button is After the first roll has been exhausted, the new-camera owner may come to his senses at last and decide to cut out the foolishness and get down to bress tacks

BALANCING THE ANGLE

MEN at work frequently offer striking subject-matter for picture makers, and one of the best viewpoints to adopt for unusual pictures is that of the up-angle. In the present illustration, the men were suitably placed for a good composition. The sary to wait for the standing man to get



"Men at Work"

could truly be said to have balance. This balance is facilitated by the fact that the man's body is slightly tilted forward. Unity is achieved, too, by the fact that both men are engaged on one thing and are facing towards each other. A filter was used for the sky.

THAT DOUBLE CHIN

OCCASIONALLY you will be confronted with the problem of how to minimize or to some extent avoid representing the double chin of your subject. This is particularly a problem with women. In modcrate cases, a shift in the angle of the head is all that will be necessary. Have the subject seated facing on an angle with relation to the camera and then turn her head towards the camera. Caution must be used here, however, to prevent too many folds in the neck, which might prove almost as

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disturbing as a multiplicity of chins. An up-tilt of the head, often very suitable for women, is another dodge. Another, perhaps more useful procedure, is to light the subject predominantly from a high position so that the minimum light reaches under the clun, by reflection, to show just a trace of printable detail there

PORTRAIT BY CANDLELIGHT

THE flame of a candle at a distance of about two feet from the subject provides sufficient illumination for an exposure of one second, or a little less, at stop 1/35 when using Super XX or Superpau Press film. To minimize slindows on the



"By Candlelight"

face, have the subject face towards tin flame. There is a tendency in this type of picture for the subject to stiffen up unduly as if awaiting some catastrophe. Try to induce the subject to assume a natural. PRSS DOSP

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that is inclined to curl somewhat. A still easier method and one that will leave the print clear of marks to the very corners, is to use double-sided adhesive. This is available in a product known as Twintak. Cut four short strips, remove the linen fabric that covers one of the adhesive sides, and attach to the under side of each of the four corners of the paper Then place the paper in the desired position on the baseboard. after having previously focused on an ordinary sheet of paper in the usual way, and the paper will stay put wherever placed.

CLEANING OLD PRINTS

HERE is a professional tip that many amateurs can put to good use Onc otographer who occasionally has to revive an old print which has become soiled for one reason or another, does so by the simple expedient of applying a thin paste of ordinary starch to the surface of the print. He allows this paste to dry for about 10 minutes. At the end of this period, he holds it under the tap and removes both starch and dirt by running water over the print.

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POR that contrasty subject, with very strong high-lights and deep shadows, we recently came across a developing solution that just about hits the nail on the head. It is called GD-33, is easily made up from familiar chemicals sure to be found on every normally equipped chemical shelf, and is extremely stable. Made up for tray use, the

ormula follows:	
Metol .	75 grains
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Hydrogunone .	20 grains
Sodium Carbonate	130 grains
Potasium Bromide	15 grains
Water to	32 ounces

ANTON F. BAUMANN

WIDELY known and admired both as W a photographer and a personality, Anton F. Baumann has shot his last picture A victim to the desire for original viewpoints in photography, Baumann, a master of 35mm technique, died while attempting an unusual picture angle.

"He had just completed a lecture and demonstration tour of a number of southern cities," says the announcement of his death, "and was making pictures when he met with an accident in an attempt to obtain a 'different' angle from a high position.

"Anton F. Baumann entered the employ of the firm of Ernst Leitz as a young boy, heing engaged in the research department. realized its possibilities and soon devoted all of his activities to making pictures and lecturing on Leica technique throughout the world. . . . His lectures and demonstrations were a delight to thousands of photography enthusiasts, for they taught them how simple it is to make enlargements from 1 by 11/2 inch negatives. When modern color films first appeared, Baumann immediately saw the possibilities of this new medium and devoted much of his time to it. He projected his slides to audiences throughout the country and inspired many photographers to work with this new medium."

WHAT'S NEW

In Photographic Equipment

If you are interested in any of the items of described below, and cannot find them in our advertising columns or at your photographic dealer, we shall be glad to tell you where you can get them Pirase accampany your request by a stamped envirope.

DUPLICATE TRANSPARENCIES FROM KODA-CHROME: 35mm duplicates, for acreen projection, or enlarged duplicate transpar encies up to 11 by 14 inches from original Kodachromes taken with miniature camera. Also, "same-size," enlarged, or reduced-size duplicates from most sizes of Professional Kodachrome Miniature sizes may he submitted, through dealer, either mounted or unmounted

ILEANY DUTY PHOTO FLOOD "HI-LO" SWITCH: Control switch capable of handling group of two, three, or four lamps drawing total power up to 2400 watts. For ex-smple-four No. 1 lsmps, four No. 2's, two No. 4's plus two No. 1's, and so on. Unit comprises steel box four inches square by two inches high, with toggle switch lever on top and pair of outlets on each of two sides. Finished in nest crackle gray. equipped with rubber-covered, heavy-duty line cord and plug. With switch in "Hi" "Lo" two pairs of outlets are connected in series, dimming illumination, reducing current drain and heating.

TRIPLE S SUPERPAN REVERSIBLE (100-foot length, \$6; 50-foot length, \$3 25): New 16mm motion picture film Rated four times faster than Agia 16mm Superpan Reversible, permitting two lens stops less exposure or corresponding increase in subject range. Speed combined with fine grain and brillient gradation.

LAFAYETTE FILTERS AND MOUNTS: Available in 12 sizes to fit all lens diameters 23 to 42mm. Include light and medium yellow, light green, medium green, and red. Mounts consist of barrel and clamping ring which screws over its outer end to hold filter glass in position. Inner end of barrel slips over lens mount and has spring fingers to insure firm grip. When clamping ring is screwed into place it does not reduce inside dianieter of mount.

WESTON MASTER, Model 715 (\$24): New model featuring separate scales for low brightness range, 1/10 to 50 foot-candles, and high brightness range to 1600 foot-candles. Manufacturers cite example of person sitting near average reading lamp at night reflecting five candles per square foot to indicate extreme sensitivity of low scale. On high brightness side, readings far higher than heretofore are provided with such subjects as heach or snow scen "High Light" scale viewing angle cut to 30 degrees for greater accuracy in measuring central point of interest, without being afrected by surrounding light. Film speed range increased, providing for film speeds from 3 to 800 Weston. More // stop-shuter combinations provided on Master calculator dial. In changing film ratings, touch button and emulsion dial moves smoothly; release and dial locks securely. Hermetically sealed housing around cell keeps moisture out. Streamlined outer case molded to fit hand, with special ribbing to prevent slipping Decorative chromium strip forms secure ribbon eyelet at end.

Speepo Print Dryer, new model (\$14.85).

Dries glossy prints plus regular matte or semi-matte papers. All-metal cabinet, with



crackle finish. Insulated Bakelite handles prevent accidentally burning fingers. Scientifically circulated and

controlled air warmed electrically. Minimum drying time, with full protection against scorching. Capacity: six 8 by 10-inch prints, five 11 by 14-inch, or more than 400 contact prints 1 by 1 1/2-inch, all in one dream.

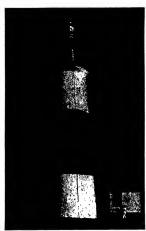
KODAK TRANSPARENCY ENLARGER (\$18.50 for complete outfit, with three filters, special masks for 35mm and "Bantain" frames, and operating instructions) For making enlarged negatives from Kodachrome trans-parencies or black-and-white film positives without using darkroom Accommodates either double-frame (1 by 1 1/2-inch) 35mm film transparencies or No. 828 film Enlarger loads with either Super XX (XX616) or Panatomic X (FX616). Negatives about 2 1/8 by 3 1/8 inches obtained from 35s film and approximately 2 1/4 by 3 5/8 inches from No. 828 frames Operation transparency, mounted or unmounted, positioned in enlarger gate end hinged diffusing-glass cover closed over it. No 1 Photoflood in reflector is held about five inches over gate, end enlarger shutter, op-erating only on "time," is opened for several seconds. About five seconds suffices with transparency of average density, using Super XX film. From enlarged negatives, any number of contact prints or greater culargements may be made.

DUANCOLOR PF CUT FILM (DOX of 6, 42 to 1871 copening on saze, 214 vb 3 1/4 to 8 by 10 inches) Infraorum DATLIGHT TYPE (CUT FILM (price range same as above): New PF type cut film affords greater speed where thirds lable. Primarily intended for whether the property of the film has second at 1/8 yields rich, clean transparences. The color balance of the film has film has filmly developed, accurately recording the simely developed.

LECA, SYNCHINOUIDE PLASH UNIT MORELY (\$28.56); by means of new baseplate, synchronization is effected by mechanism of camera itself. No external synchronizing heads, devices, or connecting wires required. Battery case attached directly to special baseplate of camera by means of dovestield silder which holds it in position. Bulb socket of griding type, Reflector adjustable for two positions depending on bulb sites. Small test lamp, located in neck of lamp socket, each as pilot for effecting

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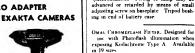


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Did w Diver (\$2.50) Electric print drying device consisting of chrominis squeegee plate in cylindrical form. Heard by a common electric light bulb. General constrution such that crolosed area quickly leafgrying satisfactory drying surface. Takes up little space.

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Placing a good negative in a poorly made en larger is like buying an expensive automobile and lubricating it with cheap oils. To obtain the utmost from miniature photography, you should work with

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FREE CATALOG





JACOB DESCIIN, conductor of our "Comera Angles" department, will answer in these columns questions of general interest to ametize photographers. If an answer is deviced by mail, enclose a stamped, addressed encelope, Queres should be specific, but MT Descrito cannot undertoke to draw comperisons between manufactured products nor to advise on the purchase of equipment or materials.—The Editor.

Q. Is it possible to change a positive movie film to a negative? If so, how? If you have any information on how to make prints, using movie film, I would appreciate it.—J. K.

A. A positive movie film is used to make a negative by the contact printing method. In our June, 1933, "What's New" column we announced the introduction of the Kodak form enlarger, by which these small movie positives may be directly enlarged on 616 film. The resulting negatives are then used for making contact prints or, if desired, still larger pictures by the enlarging process.

Q. I am thinking of buying another camers. How can I decide what camers and lens will suit my purpose? The pictures I take are distant access and anaphots of interesting objects seen when walking around with the camers. For years I have been interested in ranking color pictures and would like to know if you can give me some information on the subject. How do the Kodachrome, Dufaycolor, and Autochrome processes differ?—M.

A. Portability is probably one of the first considerations in your case. Prece and size of negative are others. If you can allow it, we would suggest the purchase of a cenera that will permit the interchange of the control of the c

As to color photography: This has been implified docky imedra as the production implifier docky imedra as the production implifier docky imedra as the production product ramparencies are concerned. If you plan to do much color photography, the sizes of color film available may have some bearing on your choice of a camera. Kodachrome. Dufaycolor, and Filmcolor (Autochrome, formerly available in platea, has been superseded by Filmcolor in cut-film form but with the Autochrome enulsion) are all similar in the sense that the color secreta and the nunchromatic emulsion have

been combined, so that exposures may be made in the same manner as ordinary black and white film. The color screen faces the and white film. The color screen faces the color of the color

Q. Can you tell me the reason for the vertical line of atain running through the center of certain negatives atored in negative enclosures?— S. F. I.

A. This is a common difficulty experienced by photographers who file negatives in enclosures having a glued or pasted seam down the center The nature of the adhesive, plus moisture, is probably the cause You should use enclosures with an edge seam and file the negatives in a dry place The stain may be removed by hardening the negative in one of the hardening baths, such as the SH-1 Formalin Hardener, and then placing the negative in a 1 or 2 percent solution of potassium cyanide until the stain disappears. Cyanide being a deadly poison, make sure the room is well ventilated and, after use, discard the solution down the drain only after having made sure that there is no acid in the sink or trap-

Q. I desire information on the use of powder for flashlight photography. Would you say that its use is the answer to getting flashlight action above to getting flashlight action above hubbs are positive, give no anode, and so on, but outside of that would the use of powder be just as good? Flease describe the technique of using powder satisfactorijy—H. B. B.

A. Flash powder today is used almost exclusively by newspaper and commercial photographers when it is required to cover a large area, particularly outdoors at night. The low cost of flash powder as compared with that of flash bulbs is greatly offset by the disadvantages of the former. The immediate swing to flash by both amediate swing to flash bulb to the disadvantages.

teur and professional photographers as soon as these became available is a certain indication that the higher cost of the bulbs has proved no drawback to widespread ac-

From your query we gather that you are sware of the main advantages of the bulb over the powder, so we won't dwell on them You probably also know that smallsize bulbs, proportionately lower in cost than the larger ones, will provide sufficient illumination at normal distances to give well-exposed negatives at small stops our opinion, chespness is the only advantage that powder has to offer over the bulb, for average working conditions Mention must be made of the hazard attending the use of powder-that of untimely explosion Special care must be used both in storing and igniting powder Flash powder is fired in a device known as a flash-pan, provided with some automatic method of ignition. The powder must lie exposed and not confined in a container of any sort A brief flash is obtained when powder is heaped in one spot, a longer flash when the powder is spread over the pan, thus insuring the maximum of light Instructions are supplied with each container of

- Q. Since I do not own a scale with which to weigh chemicals when mixing developer, can you tell me how to measure out chemicals, using tableapoon measurement?—F. H. J.
- We would if we could but we can't The fact is, chemicals vary in weight and so would necessitate a different table of measurements for different chemicals. While the weighing of chemicals for the compounding of photographic solutions does not always have to be critically accurate, the use of a tablespoon system of measurement would be stretching the point a little too far. By employing one of those vari-sized spoon sets used in weighing out cooking recines, it is altogether possible to figure out a method for preparing formulas, but a weighing scale would be necessary to fix the quantities. Scales are not expensive and sometimes may be nicked un second hand for much less than their original cost. In this connection, the dollar Weigh-Spoon device mentioned in our "What's New" column some time ago should be suitable. If you employ standard developer formulas, these, as you probably know, are available ready prepared in dry form, requiring merely a stated quantity of water to make them ready for use. One manufacturer solved the problem you have in mind by providing wooden measures in each package of chemicals. These are sold under the name of "Mak-a-tube" (de-veloper), "Mak-a-fix" (fixer), and so on.
- Q. What causes a partial reversal of the negative image in the course of development?—P. R.
- A. The reason may lie in fogging caused by the use of an unsafe light in the darkroom or in extreme over-exposure while in the camera. Another cause is the use of an oxidized developer.
- Q. I write music as a vocation and follow photography as a hobby. When I receive an order, for, say, 50 copies of the same piece of music, I would like to be able to make the first copy by hand and from that reproduce the

other 49 copies with the camera. Can you tell me how I can photographically copy music on both sides of the

same sheet of paper?—H. K. J.

A. Aside from the method of individually sensitizing each side of the paper, you can employ a double-coated paper expressly made for the purpose you have in mind However, because there is so little demand for this kind of paper, it will be necessary for you to purchase a fairly large quantity. But since moderate quantity reproduction is required, this should offer no problem. We understand that a paper of this type, sold in large rolls, is obtainable from the Gevaert Company of America, 423 West 55th Street, New York City The company will cut the paper up into the sizes you specify We would suggest that you write to the company and state your problem, making clear your requirements, which will include the facts that the paper must be non-glossy and thin and flexible enough to permit folding without cracking

- Q. What do I have to do in order to print on special cards some of the pictures which I have taken?—Mrs. C. W. R.
- A. The first step is to convert the cardinto regular photographic paper by sensitizing them according to the formula given in our reply to E. W. D. in the September, 1938, ssaue. When that has been done the rest of the procedure will be similar to that employed in the contact printing routine.
- Q. My No. 1 Auto Self-Timer exerts, in my opinion, a very great pressure, so great that I am afraid to use it lest it shall break or bend the tiny trip bar located under the cable release socket. Please advise if there is any danger of damaging the shutter in this manner. —A. K. B.
- A The pressure you refer to is necessitated by the nature of the timer's design, but will do no harm to the shutter. There is no adjustment on the No. 1 timer for the pressure required to set up the delay mechanism, as there is on the No. 2 timer You can, however, feel secure in using this timer without danger of damage
- Q. How can I enlarge from a wet negative?—R. L.
- A. Make a glyceruse "andwich" beveen two pieces of clear glass. Apply a little glyceruse in the center of one glass. Apply a little glyceruse in the center of one glass, the west negative on it and apply another drop on top of the negative. Place the other glass on top of the negative. When sand-wiched together, the glycerine will spread, overring the entire negative and thus preventing premature drying of the negative while being projected in the enlarger.
- Q. What is a good way to copy a photograph made on a matte surface —L. D. G.
- A. In order to overcome the disadvantage of the matter effect for copying purposes, and to help bring out shadow dotail, mamerse the print in water, let a took a while, and then lay it face down on a sheet, of plain glass. Squegee at down firmly until all bubbles and air pockets have disspeared. Make sure the glass is clean before you lay down the print. Face the print, through it glass "cover," towards the camera, and light it evenly by using two light sources of equal intensity, one on each side.

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"THE mirror is a Chance disk, 3 1/2" thick, with a focal length if 120". The aperture is 30" (f/4). It is floated on a system of triangular supports, contacting the underside of the mirror at 18 points.



Figure 1: Cross-section of the cell

l Hindle's well-known system, described in the book 'Amateur Telescope Making,' page 229.—Ed l. A cross-section of the mirror cell, with reference to the edge support, is shown in Figure 1. The annular ring,

"The tube is constructed from solid-drawn steel conduit, such as is used for electrical

for the extraction of the mirror.



Figure 2: The tube construction

wiring purposes, and the lengths are threaded through circular rings of heatrested, high tensile slumnum alloy. These rings are securely clamped to each tube by means of a taper fitting such as is used for attaching ball bearings to a straight shaft (Figure 2). The diagonal bracing is of high tensile steel wire, which is pulled taut by means of screws at the bottom end of each tube, near the mirror moont. A perfectly rigid tube of minimum weight is thus obtained

"The four arms of the spider carrying the diagonal are of phosphor bronze sheet, mounted on the extreme end ring, with provision for concentric adjustment.

"The diagonal mirror is 7" minor axis, and about 1 1/2" thick, mounted in an alumnum and brass cell which has a tubular stem, so that electrical means of slightly rassing the temperature of the back side of the plane, to avoid dewing, can be adopted, as described in 'ATMA' by Dr. Steavenon.

"The pumary mrow is not perforated. It is collimated with reference to the brass sleeve which forms the center of the spider, returning its reflection precisely concentre with a ground spot, exactly in the center of the mirror itself. The expelce support can be readily detached from the tube in necessary, and there is a considerable necessary, and there is a considerable supported at three points, the final set is a supported at three points, the final set is the property of the property o

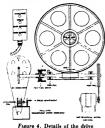
"The polar axis is built from a 5" steel tube, with 1" thick walls, and the ends plugged solid. It is supported in ball bearings, one immediately below the fork, and the other immediately below the worm wheel. The general design of the mount





Figure 3: The nearly completed telescope erected in Hindle's plant (Union Engineering Works)

for a latitude of \$1.1/2* is clearly seen from Figure \$2\$, the fort isself being a substantial iron casting of 'U' section, split where it also on the top of the boler aris, to which it is firmly attached by compress on bolts. A segment of a worm wheel on the trunnion of the tube enables the electope to be adjusted in declination, through the medium of a worm and spur gear, with a featile joint to a brown handle



within reach of the observer. When the

inclined steel handle and its nut are relessed, the tube can be moved to any approximate position by hand

"The drive to the polar axis is possibly to some extent novel The worm wheel on the polar axis is definitely fixed to it, the usual clutch being dispensed with. That enables the wheel itself to be more precisely mounted, and the engagement of the worm and wheel more definitely adjusted The primary drive is by gramophone motor, through a 60-to-1 worm gear, which, in turn, through a friction drive, rotates the main worm shaft and the wheel on the polar axis, the latter reduction being 360to-1 (Figure 4). Particular attention is directed to the small worm gear, which is carefully assembled and runs in ball journals to reduce friction to a minimum, so that the gramophone motor is not overloaded. The pitch of worm and wheel is 10 D.P., that is π/10, and the pitch-circle diameter of the worm is 0.75", so that the angle of the thread is 7 1/2", which practically gives irreversibility. The compression springs on the friction drive enable the necessary power, with an ample margin, to be transmitted to the main worm shaft.

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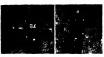
THE BEGINNER'S CORNER

RIPODS instead of fixed pedestals are TRIPODS instead of fixed possessions of first desirable in many instances for first telescopes, because first telescopes usually are small enough to be portable Light, flursy tripods, however, are too shaky for a telescope, because the telescope magnifies



solid, he-man tripod should be built, in stead of the too common "pansy frail" Give it good hisky legs. Usually, however, you will want it portable, but its length will defeat this unless you make it jointed-and then comes the question of a joint that won't, in turn, defeat the effort to make it rigid.

One kind of folding legs is shown in the accompanying photographs of a tripod made by F. M. Garland, 1006 Davis Ave., Pittsburgh, Pa. These fold outward and upward,



rather than inward, and thus nest closes when folded The tripod has three hinged central braces in addition, made of strap metal slotted for adjustment and provided with a wingnut for tightening braces are far enough above the knee joints of the legs so that they will not extend be

low the latter when the tripod is folded Main feature of Garland's tripod is the knee-joint which, once locked, is as solid as a human knee in a plaster cast. On the outer not the inner-side of each log i a heavy backflap hinge, as shown in the lefthand closeup, and on the inner sides are metal straps pivoted at their tops on a screw and side slotted near their bottoms. Each slot has a bolt and wingnut for tightening

Other stiffening and strengthening details show in the photographs. The tripod shown weighs about 15 pounds and is very rigid The refractor seen on it is an old 3 1/2" Brashear

TELESCOPTICS

(Continued from preceding page)

the reder axis makes a complete revolutron in about a minute. Owing to the limitation of power that can be transmitted by the friction drive, and the practical preversibility of the small worm gear, the graniophone motor is quite unaffected by the rapid adjustment taking place, and continues to run on as usual limmediately, therefore, after the 1/4 hp motor is disconnected, the friction drive instantly resumes its functions without any lag or loss of time whatever During normal working, the 1/4 h p motor rotates tells, very slowly

Weights of individual parts of the intrument are as follows

Mounting, including fabricated R S. C foundation, baseplate,

Mirror

polar axis, fork, bracket, and ootstool castings 2399 lbs Tube with flat and its cover 577 lbs Cell and mirror supports 385 lbs 196 lbs

Total 3557 lbs.

This ends Hindle's description Readers of "ATM" and "ATMA" will recognize him as a co author of those books By vocation he is a manufacturer of loomsthose very heavy ones of 30 tons or so such as are used in weaving the dryer felts of cotton, thick and wide, used by papermakers. The same readers will recall the picture of a 30" mirror on a granding machine, on page 245 of "ATM" (fourth edition of 1935), this is the same mirror Hindle enjoys making telescopes Having made them, he gives them away! However, lest about 10,000 readers obey that impulse to rush applications for free 30° reflectors by cable, we hasten to add that he hasn't exactly given away his two large telescopes, a previous 20 1/2" and this 30", in quite that way. He has, however, commendably arranged to place them where they will work hard for astronomy. The 20 1/2" (see its photo in "ATM," page 153) has been in the hands of Dr. W Steavenson, a pronunent English variable star observer, more wolchy known by hundreds of astronomical friends in Britain end America as "Steave," who contributed the chapter on dewing of optical surfaces, in "ATMA" The new 30" is being mounted in the grounds at Cambridge University Observatory by arrangement with Sir Arthur Eddington, where it will be available for the use of the Professor's staff Later Dr. Steavenson hopes to be in a position to make regular use of the newer instrument himself

LAST month in this department there was a long article by Hendrix and Christie, of the Mt Wilson Observatory, on the Schmidt camera, and now we have the following comments on that article written by Prof C H Smiley, Director of the Ladd Observatory at Brown University and a leading exponent of the Schmidt camera;

"It is with some hesitancy and considerable distaste for the task that this criticism of the article by Hendrix and Christie in last month's Scientific American is written. I am deeply indebted to Mr. A. H. Joy of the Mt, Wilson Observatory and to leave retent to Mr. Hendrix for valuable asstance and advice in 1937 in connection with improvements made on the Ladd Observatory Schmidt camera which had just been completed. I am well aware that Mr. Hendrix has made more Schmidt camera, that any one else on earth. If I were asked where the outstanding authorities in astronomical optical work were located, Mt. Wilson Observatory and Hendrix and Christie would come first to my mind

"Even so, one of the sentences early in the article by Headrix and Christin seems to me to be distinctly inflate." "several arnicles have been written about the 'chimid camera since the unventor set forth arprinciples in 1843, but little that in new principles in 1843, but little that in new hard that it is not a series of the series of the table that is not a series of the series of the internal series of the series of the series of give a multi-maried design for the correcting plate, he did not give any method of testing nor was his method of mixing a correcting plate revealed to the public mixing the series of the rese lives been used out of the series of the F B Wright, B Strongren, H \ Lower, Y \text{ Lower, Y

"One might overbook a single ingenerous remark in the early part of the article but a considerable amount of material presented in the latter part of the article has previously been published by others, yet the article does not indicate this. A recent letter from Christie suggests that Hendrix and he knew all these things before others published them I do not question the vit acity of this statement. However, priority in scientific matters is usually established by publication in a journal generally avail able to others. On this basis, F. B. Wright and B Stromgren should receive credit for their publication of the matternatical design of the correcting plate, and other acknowledgments of priority in publication should have been made

"In brief, I feel that the ingenerous and moderating statement concerning carba." In brief, I feel that the innermon the publications and the failure to mention the publications and the failure to mention the statement of the publication of the interest of the past five years and have withheld it from publication during that interest.

RULE for finding sagitta of a mirror, expressed directly in sixteenths of an inch, offered by Joseph Dwight, Hvaimis, Mass Divide aperture by focal ratio.

To measure depth of sagitta on a mirror while roughing out, Lloyd Anderson, 11909 Vicenie Blivd, West Los Angeles, Cahi, pius a small drop of soft pitch at the center and places a sivel sizight-redge across the mirror, pressing the pitch down Then, with thickness of the pitch. Automatic feeler?

POREIGN telescopues as one of the bold but for of R. I. Beardwley, 2515 W. 21 St., Los Angeles, Calri, who reads about 769 foreign languages. He asys G. O. Bjordal, Box 111, Askim, Ostfold, Norway, is one of five TNs in that soon who would like to receive photographs of American TN's telescopes. They read English.



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New Houszons or Industry Tranductor Richards in a Galpage bookler that presents "a tour through the present into the future" it covers scentific research and its applications in industry throughout a bread field tranging from automobiles and chemical through health and homes to rosds, rubber, vision, and wood. It is essentially a high-lighted survey of what will be accomplished in the future, based upon accomplishments in the future, based upon accomplishments in the future, based upon accomplishments for the future of the futur

METALLIZING HANDBOOK is a 26-page booklet which gives complete details on metal spraying, together with a series of pictures which shows specific applications. The equipment necessary for such work is listed. Metallizing Company of America Inc., 562 West Washington Boulevard, Chicago, Illinois - Craits.

TYPICAL NICKEL ALIOY STRAIS AND CAST IRONS EMPLOYED IN DUSSE. CONSTRUCTION is a single sheet tabulation which covers these metals as used in light, medium, and heavy Diesel eigines. It tabulates engine parts, recommended compositions, mechanical properties, and best treatment. The International Nickel Company, 67 Wall Street, New York City.—Gratis.

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SEALAIR Winoows is a 10-page, completely illustrated booklet which shows and describes all-alumnaum windows in stock and standard sizes it should be of particular interest to the bome owner who is considering building or rebuilding. The Kauncer Company, Nules, Michigan—Gratis

Practical Television by RCA is a 40-page book which is particularly concerned with circuit design, antenna installation, and reception. It is published for service men, dealers, schools, and anyone interested in a survey of television as it stands today. It presents a general discussion, technical description of receiving circuits, details of television receivers, a section devoted to general service problems, and a group of television definitions. Obtainable from RCA distributors or direct from RCA damalgacturing Company, Camden, New Jussey.—25 cents.

New Photography Recome is a stemgraphic report of the second annual short course in news photography at Kent State University. It covers, in lecture form, practically the entire field of photography, from the lastest developments in cameras and equipment to color photography, photography and the professor of Journalism, Kent State University, Kent, Ohio.—425.8

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ALLID'S RAPO BULDEN's HADDROOK is a 30 page, thoroughly illustrated booklet which gives the reader some theoretical background, together with a knowledge of rado circuits. A short section is also devoted to anateur radio—how to operate matteur radio—how to operate matteur radio—how to operate received in the received of the received to anateur radio—and the received in code. A group of circuit discrepance of the reader something concrete to work on. Allied Radio Corporation, Serves Jackson Boulevard, Chicago, Illinois.

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This American Way in Industrial Research is an 8-page illustrated reprint which describes specifically the work of Mellon Institute and other institutions which are today shaping our industrial future by the work which they are doing in various fields of research. Mellon Institute of Industrial Research, Pittsburgh, Pepasylvania.—Gratis.

LEGAL HIGH-LIGHTS

Patent, Trade Mark, and Related Legal Proceedings That May Have a Direct Effect on Your Business

By ORSON D. MUNN, Litt.B., L.L.B., Sc.D.

New York Bar Editor Scientific American

BATTLE OF BATHS

WO bath preparations similar to bath Two bath preparations summer, were salts, both bearing French names, were involved in a recent suit for unfair competition and trade-mark infringement. The manufacturer of a bath preparation bearing the trade mark "Bain de Champagne" brought sint against a competitor selling a bath preparation under the name "Bain Mousseux charging that the names were confusingly similar to each other It was pointed out that the word "Bain" meant bath and that accordingly the plaintiff's trade mark meant bath of champagne whereas the defendant's trade mark meant sparkling bath The defendant's preparation when added to the water in a bath conveyed a sparkling or effer-vescent character thereto. The plaintiff contended that the word "sparkling" used in the gest champagne and for that reason the defendant's name would necessarily be confused with plaintiff's.

The court, however, pointed out that in sound and appearance the two names were quite different and that furthermore the word sparking suggested many other products be-aides champagne. Since the defendant's name was merely descriptive of one of the characteristics of the preparation the court refused to restrain the use thereof.

CHORUS

THIOSE of us who have difficulty in remembering more than the chorus of a song and find ourselves humming or singing the chorus of a song over and over again will receive a certain amount of moral sustenance from the judicial declaration that the chorus forms a substantial portion of a ment the owner of the copyrights on two songs charged that a printing company was sulty of copyragin infringement because it

had sold printed copies of the choruses.
One of the defenses raised was that one of the mere copying of the choruses did not constitute an infringement of the copyrights because the choruses did not constitute substantial and material parts of the songs. The Court held that this defense was without mert, stating.

"The chorus of a musical composition may constitute a material and substantial part of the work and it is frequently the very part that makes it popular and valuable."

TURN AROUND

IN a recent decision of a Federal Court
the trade mark Run-R-Stop was held to
be infringed by the trade mark Stop-A-Run.
In the suit is question the manufacturer of

a find to be used in stopping runs in all, assockings charged a competition, making a similar product, with unfair competition and trade-mark infringement. The Court found that the planniff had used its trade mark Run-R-Stop for many years, had spent a great deal of more join advertising, and deathy established a secondary of the purchasing public that the product was manufactured by the planniff.

manusctured by the plantin.

The Court recognized the differences between the two names but came to the conclusion that, due to the euphonous similarity between them and due to the further fact that the packaging and dressing of the two products were very similar, the use of the name Stop-ARun by defendant was likely to lead to confusion and constituted trade-mark infunsement.

ADDENDUM AND

DEDENDUM

THE Court of Customs and Patent App peals has allowed a patent on toothed gearing in which the teeth of the driving pinon are all-addendum and the teeth of the driven wheel are all-defendum and with a pressure angle lying hetween 22% degrees and 30 degrees. The terms addendum as and decindum as applied to gearing means that the treth are outside and made respectively correles passing through the pinth point of the pitch erroles. The pitch point of the pitch erroles. The pitch point of the pitch errole are circles passing through the pitch point of the pitch errole. The pitch which are coastale with the area thereof.

The Patent Office had refused to allow the patent on the grounds that the provision of pinnons in which the teeth were all-adendum or all-defendum was old and that the pressure angle of the teeth was more ries optional. On appeal the Court of Customs and Patent Appeals reversed the Patent Office and held that the pressure and produced new results which were not attituded by the patent office and the patent office attitude to the produced new results which were not attituded by rior to the inventors.

In reaching its decision the Court was influenced by the affidavits of several experts who told of the many years of expermentation required to develop the gearing and also stated that the particular angles referred to were critical.

JEWELLED SHROUD

THE utility of a design has no bearing upon the validity of a design patent This principle of patent law is illustrated by a recent suit for infringement of a design patent for an automobile exhaust

Briefly stated, the design patent related

to an exhaust through having a aloping too surface in which a glass reflector; pred was mounted so that the headlights of a car approaching from the rear would be reflected by the swell After considering the elements of the design or appearance of the shroud and finding that they were of more or less conventional character the court hardly considered the utility or function of court pointed to that the surface of the surfa

"Moreover, we must keep in mind that the utility of the combination of the glass jewel and the exhaust shroud is not involved. Utility plays no part in determining the validity of a design patent."

PROFESSIONAL

MISREPRESENTATION

A RATHER novel defense was raised in a recreat proceedings hrough by the Federal Trade Commission against a manuacturer of a soap and outnemn used in the treatment of skin duesses. The Federal Trade Commission charged that the manufacturer was guilty of unfair methods of competition because of mareprecentations appearing in certain of the advertisement of the adve

One of the defenses raised by the manufacturer was that the adventuements in question appeared in a professional journal and that the physicians who read the journal would not be misled due to their medical knowledge A. Federal Circuit Court of Appeals rejected his defense on the grounds that if the adventuements were false and misleading it was immaterial whether and on plus final readers were actually misled on plus final readers were actually misled

The Court also stated:

"Conceding the somewhat violent assumption that prospective patients never read medical and nursing journals, we do not concede either the ethics or the law of a proposition which puts a premium on a failure in wickedness."

B. O.

RATHER intunate and personal issues were considered by the Patient Office tribunals as a recent opposition by a prior-inent soap manufacturer against the application of the patient of th

The Court found that the soap manufacturer would be damaged by the registration of the trade mark "Nohio" and refused to permit the registration, stating:

"Il is evident, we think, that, although the terms 'Nobio' and 'B. O.' do not look exactive alike, the term 'Nobio' and be pronounced as though it were spelled 'No-B-O'; that appellee intended that its term 'Nobio' should he understood as meaning 'no B. O' (no body odor), and that it will he so understood hy the purchasing public."

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CONTRIBUTING EDITORS

L. WARRINGTON CHUBB, Director of Besearch Laboratories, Westinghouse Electric and Manu-facturing Company

JACOB DESCHIN, Ameteur Photography CHURCHILL EISENHART, Department of Mathematics, University of Wiscoman Statis-tician, Wiscoman Agricultural Station MORRIS FISHBEIN M.D. Editor of the Journal of the American Medical Association and of

WILLIAM K. GREGORY, Professor of Vertebrate Paleontology, Columbia University

LEON A HAUSMAN, Professor of Zoology, New Jersey College for Women

WALDEMAR KAEMPFFERT, New York Times, 1RVING LANGMUIR, Associate Director, Re-search Laboratury of the General Electric Com-pany, Schenociady

D. I. MacDODGAL, Associate in Plant Biology Carnegie Institution of Washington

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SCIENTIFIC AMERICAN

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NINETY-FIFTH YEAR . ORSON D. MUNN, Editor

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50 Years Ago in . . .



(Condensed From Issues of October, 1889)

MAINE—"The steel cruser Maine, in course of construction at the Brooklyn Navy Yard, is now in skeleton condition, most of the frames being up. When completed she will be the largest vessel ever built for the United States Navy, being of 6648 tons displacement. The mammoth shed where the work is in progress was erected

during the Civil War Doubtless, to its constructions, the dimensions of this shed seemed sufficient for the longest craft that was likely to he built. Yet the prow of the Maine, with its steel ram and spur, extends many yards into the open. Inside this shed nearly three hundred men are now at work."

BENDING - "The largest bending rolls that the Niles

Tool Works are now building for the Mare Island Navy Yard, San Francisco, possess very interesting features. This machine will bean mild steel plates 2 in. thick by 22 ft wide. It is guaranteed to bend armor plate 1½ in. thick by 22 ft wide. The work is done by four forged rollers, two in the center, stranged one vertically over the other, to grap the sheet between them, and one on either side of the center to hend the sheet."

FLOOD.—"During the Conemaugh flood, thurty-two locomotives, some of them weighing 91,640 lbs., were tossed about like corks, 23 of them being conveyed an average distance of 1347 feet down stream, one soung 4844 feet, the shortest trip being 480 feet."

PARCELS POST—"In June last the Postmaster-General submitted to the Chillian minister the draught of a convention between the republic of Chile and the United States for the establishment of a parcels post system and a postal money order system between the two nations."

TRANSANDINE RAILWAY.—"The Andes are being crossed at the Uspallate or Cumbre Pass, where there will he a tunnel \$\text{SI}\$ mules in length, at an elevation of 10,450 ft. above sea level. The pass itself is nearly 3000 feet higher, or at 13,015 ft. and is situated 4½ miles south of Aconcagua and 334 miles north of Tupungato, in 33 degrees \$\text{S}\$ lattude. It will thus he seen that the ummut level of the Transandine Railway is far above any European lines, which at the Rigi reach to 5753 ft., and at the \$\text{S}\$ Cothard 3786 ft."

WAGES.—"Some paper has natted the nilly question, 'Do Inventions Decrease Wages?' Certainly they do not. On the contrary, mentions increase wages, shorten the work day, and decrease prices. In fact, inventions constitute the only possible way by which labor can be emancipated from drudgery, long hours, and poor pay. Inventions are increasing every year, and wages are contently advancing in all countries where they are utilited."

YELLOW FEVER—"D: George M. Sternberg, surgeon in the United States Army, has past returned from a ax month; any in Cuba, where he has been continuing his researches with reference in yellow fever. He has brought with him specimens of microbes, with which he will continue his investigations during the winter at the Johns Hopkine University.

PHONOGRAPH—"in reply to numerous inquiries we can only say the phonograph has not yet been reduced to that simplicity and perfection of operation necessary for its general sale and introduction. It is true, several examples have been produced which are in use, and many interesting experiments have been made.

But in most cases, in order to get really assistatency recalls, we believe in needs the employment of an expert to watch, adjust, and work the instruments We are informed the machine has recently been improved to as to dispense with all adjustments, thereby rendering it entirely automents, thereby rendering it entirely automation of the property of the property reached this stage of simplicity and prereached this stage of simplicity and prefection, we predict for it a bright future."

WHEELS—"Carriage manufacturers are predicting that in the not distant future wooden wheels will be done away with,

wooden wheels will be done away with, and steel wheels substituted, on account of the increasing scarcity of lumber for wheels."

CRUISER SPEED.—"Advices from San Francisco state that the calculations regarding the horse power speed developed by the cruser Charleson, just completed by the trial board, show a maximum horse power of 7093 and an average horse power of 6816 for four hours, average speed, 18.75 knots, though a maximum of 19½ knots was developed for a short time."

DANGER.—'The most currous protest against railways ... was that drawn up by the Royal College of Bavarnan Doctors, recently discovered in the archives of the Numberg Railways at Furth, the text German line constructed. It contains the following passage, ponting out the danger of the new system of travel: Travel in carriages drawn by a locomotive ought to be forbidden in the interest of public health. The rapid movement cannot fail to produce among the passengers the mental affection known as

DRILL—"An interesting electrical machine can be seen in operation on the framework of the new warning Maine, in the Brooklyn Nay Yard. It is a drill Instead of the slow and tedious pawl and ratchet hand drill commonly used, is one that is set a-whiting by an electrical current sent through carefully insulated wires. A three-quarter inch hole in a three-quarter inch plate can be drilled in less than a minute."

AND NOW FOR THE FUTURE

SDefense of American Ports Against Possible Invasion, by F. D. McHugh.

In the Home Land of the Earliest Settlers of the Valley of the Nile, hy Major R. A. Bagnold.

The Mesotron, and How Modern Physicists Tracked it Down, by Charles W. Sheppard.

Protecting the City of Los Angeles Against Floods, by Andrew R. Boone.

TMan, as a Machine, is a Mechanical Miast, by G. H. Estabrooks.



TO USE BECAUSE BACK OF IT THERE ARE
FRIENDLY AND COMPETENT PEOPLE SERVING YOU . . . ABOUT 300,000 OF THEM

BELL TELEPHONE SYSTEM



OUR POINT OF VIEW

Co-operation

HOPE for a future of asfer motoring, and for longer lives for embers of the motoring public, may be gleaned from three articles in the present number. First is "Insanity at the Wheel." on page 199, econd is "Self-Contained Unit Headlight," and third is "Motoring Eye Health for 1940." the last two appearing in the Digest section. It does not take much reading between the lines to realize that here are examples of the section of the sectio

With psychiatry bending commendable efforts toward weeding out the unfit among drivers (we hope this will continue on an ever-ganding scale), the electrical industry directing research toward better and safer lighting for motor cars, and the glass companier developing better and safer safety glass for windshields and car windows, we find many reasons to believe that the death toll on the highways, reduced in 1938, will be still further reduced during 1939 and 1940.

Now, if more and more drivers will only awaken to a realization of what is being done to protect them squant themselves and will contribute their share to the co-operative effort, we can really get somewhere in the matter of highway asfety. Naive though it may seem at first blush, it is nevertheless a fundamental truth of motoring that individual applications of the Golden Rule to the rules of the road will go a long way toward making for safer and happier driving —A. P. P.

Pan-American Trade

TRADE with Mexico and consultation of the South America looms large in the thoughts of some of this country's commercial interests. Partly, there is the profit motive but more important is the item of self defense. Freer intercourse between the peoples of the Americas. more enlightened good-will and mutual respect, and an equable exchange of goods and services, all will assist in stemming the tide of foreign ideologies which threaten the peace and independence of several of our southern neighbors. The less this hemisphere is dependent upon nations of other parts of the world, the less likely there is to be coercron-economic, political, and socialfrom those quarters.

Yet despite the need for closer cooperation so that our export-import

T. Hart Anderson

RICHNESS of achievement marked the life of T. Hart Anderson, nationally known pate on lawyer and director of vicinities American, who passed owly at his hart care of the control of the c

"Judge" Anderson's genial smile will long jive in the memories of his friends and associates. Many will, indeed, contame to try to emulate him, for he had astained that precious friendly calmines, so rare in these raibing times, that remains unraffied by the diffairs of little men. Posessed of a judge-like dignily and a superior knowledge of law—specially of that pertaining to expectally of that pertaining to expect all which the pertaining to expect all which the pertaining to grow the pertain of the men and dedicated on the expect and the

His gentle manner, coupled with his many successes in significant litigation, suggest as an epitaph for him the old Latin phrase of lawyers "Suaviter in mode, fortiter in re."

problems might be solved, there are those who blandly refuse to open their minds to logic. Notorous is the hatred some South Americans have for the United States. This attitude, however, is understandable—and curable, too, if it is properly attacked, vigorously and with open minds and sympathetic hearts. But those who despose all Norte Americanos fall far short of being as stupid as some in this country who wish to increase their export business. These are the ones who, with important export products, never, or half-heartedly, attempt to get the prospective buyer's viewpoint.

Many American companies think that they can get foreign bissiness by the same tactics with which they get it at home. They believe the star safesman in the States can get volumes of bissiness abroad whether he knows the language, habits and customs, likes and dislikes, and manner of doing business of the foreign people to whom he would sell. These same companies answer their foreign correspondence incompletely and apathetically. Cases are known in which queries, involving the expenditure of

large sums, when sent to European producers and to this country simultaneously, elicited detailed answers by air mail from the former, with technical data and catalogs, and a mere acknowledgment by ordinary mail from the American companies concerned.

The answer is obvious. If we are to repand our expand our expand to respect trade—if we really want to!—and thus keep our farms and factories operating at a higher efficiency, we must develop a new understanding of the problem. It becomes necessary that are to be considered to the control of the problem. It becomes necessary that our system and then use a little gray matter to correct them. The stakes are worth te-for all the Americas.—F.D. M.

Degrees, Comfort

E VERYBODY knows that there are days when the thermometer is a liar. On a given day in midsummer, let us say, it stands at 88 degrees, which is really hot in some places, yet the day may be quite agreeable. Perhaps on the next day the mercury has fallen a full ten degrees. yet life may be almost unbearable. We say that the first day was dry, while the second was muggy. In more scientific terminology, the relative humidity-that is, the ratio of the amount of water vapor mixed with a given amount of air to the amount that the same air will hold at the same temperature—has changed from low to high. Moving up more closely to what actually goes on when the muggy day comes, the number of water vapor molecules in the air has increased, the effect is to cause a larger number of speeding molecules to leave the air adracent to the victim and add themselves to the sticky film of liquid in which he is bathed, in proportion to those which, similarly speeding, simultaneously escape from him. Thus his net evaporation is reduced and he probably goes around all day "beefing" about it's being hot and getting himself glared at by others who already know it. Yet on such a day it isn't as hot as it was yesterday when it was so comfortable.

A thermometer gives but one factor in measuring bodily comfort; relative humidity adds a second, while a third is str movement.

An matrument combining these three factors is now available but before its use can become widespread the public must be taught what relative humidity is. By publishing relative humidity percantages some newspapers arouse curriculty and in time the scientific point of view may be inculeated. Good work—keep it up.—4. G. I.

Personalities in Science

ONE generally thinks of an engineer as a technical man talking in mathematical terms and thinking with a slide rule. But O. B. Hanson, vice-president and chief engineer of the National Broadcasting Company, is one of the rare exceptions,

"OB." as Hanson is known to his associates, is essentially an artist with the inquisitive mind of a scientist. Thinking in terms of an artist and working as a scientist is the secret of Hanson's achievements in the field of radio and television.

Born at Huddersfield, England, Hanson was brought to this country at the age of one, when his father moved the family woolen business to Connecticut. Young Hanson showing an early aptitude for music and drawing, his family later sent him back to England for eight years of study at the Royal Masonic Institute in Hertfordshire where. in addition to his regular classes, he had special instruction on the violin.

Hanson says that he never really cared for the violin and wanted to play the piano, but his family insisted. However, he had no intention of making music his life work. He would probably have become an architect, if it hadn't been for the sudden death of his father. That event put an end to his ideas for a higher education and, as a boy of 16, he returned to America and went to work in the Underwood Typewriter Company's factory at Hartford. Connecticut.

Hanson's interests became centered on wireless telegraphy in 1912 when the Titanic rammed an iceberg in the North Atlantic and sank with an appalling loss of life; for it was only through the ship's wireless that a horrified world learned of the tragedy. It was not wireless telegraphy as such, however, that intrigued the eager youngster; it was the unexplored possibilities of its development. He soon began to think in terms of radio telephony and, later, of television. Here was work to tax the artist's imagination and bring into play all the skill of the scientist. Here was his life's job, an



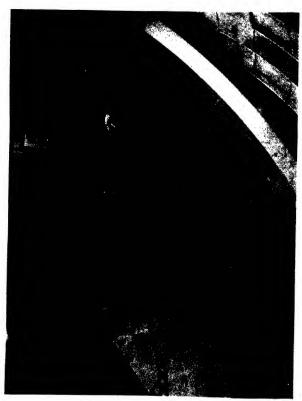
O. B. HANSON

unexplored field in which he could revel In 1917, Hanson became a member of the Marconi Company's engineering staff, rising to the position of chief testing engineer in six months. The war over, he had a short fling as head of his own electrical business in Hartford Then in 1920, station KDKA, Pittsburgh, owned by the Westinghouse Company, had begun regular broadcasting and Hanson built himself a receiver and listened to the first test transmis sions. Immediately his course was de cided. That course led eventually to his present position.

However, as in all good stories, young Hanson started at the bottom of the radio ladder His first job was with station WAAM, Newark, New Jersey, where he held the various positions of chief engineer, operating engineer, program director, and announcer. For all practical purposes, Hanson was station WAAM. In the years that have followed, the world has seen the rapid rise of radio as an art and as an industry. Hanson's own rise has been always a step ahead.

It is not an exaggeration to say that Hanson lives, eats, and sleeps his work. His home at Westport, Connecticut, is a veritable testing ground for technical improvements in both radio and television He designed it himself and it contains many special features that only an artistic man of science could possibly have continued. Even his hobbiesphotography, yachting, and music-become factors in his regular work; photography he finds has given him many useful ideas in the development of television; on his yacht he has been able to carry out much experimental work in marine radio telephone; music is almost a fundamental of radio programs.

Hanson is a bachelor. His present family consists of a registered black and white Springer spaniel with a litter of eight pups. He is a fellow in the Acoustical Society of America, and a life member of the Veteran Wireless Operators Association Incorporated.



WHERE, OH WHERE HAS MY LITTLE TRUCK GONE?

THE huge dome for the new 200-inch telescope on Mr. Palomar, California, is 137 feet in diameter, 137 feet high. Near the top, to lift the giant parts of the telescope, is a 60-ion crane, permanent. During the assembly of the telescope, states Russell W. Porter in transmitting this photograph taken by Ted Watterson, the engineer in charge of construction found a one-ton truck on the ground floor where he had cordered the space kept clear. A fling was attached to the truck and it was hoisted and left 100 feet of the truck and it was hoisted and left 100 feet of the discovered the next morning by the astonisht to be discovered the next morning by the astonisht to be discovered the next morning by the astonisht to be discovered the next morning by the astonisht to be discovered the next morning by the astonisht to be discovered the next morning by the astonisht to be discovered the next morning by the astonisht to be discovered one and telescope.



Diregard of signals causes injury or death to thousands nigury or death to thousands application of the examination methods discussed in the article below, it would be possible to eliminate from the highways those drivers who, because of physical or mental instability, enanto the depended upon to observe those rules of the road which must be hee'ded if safety for everyone is to be arbitreed.

Insanity At The Wheel

SWAGGERING into the Detroit license bureau, T-102 was blissfully unaware of the blow that fate was about to deal him. He had lost his tax driving permit and driver's heense some weeks earlier, and now demanded permisson to resume earning his livelihood by piloting a cab through the streets of the nation's fourth city.

"See Judge Maher," said the man at the counter, and T-102 swaggered out, confident that the judge would restore him to his seat behind the wheel.

Into the austere courtroom of Traffic Judge Thomas F. Maher walked T-102 next morning, and hardly had his law-yer presented a petition for recovery of lost privileges than the judge passed him along: "Have a talk with the traffic psychotechnologist."

T-102 blinked at this command, comprehending not at all, and shortly thereafter stepped briskly from the elevator into the 17th floor hallway of nearby Barlum Tower, opened a door marked "Psychopathic Clinic," and handed across the counter the brief court order requesting his examination.

It was here the 36-year-old taxi driver became T-102, a psychological guinea pig in whom Alan Canty, the psychotechnologist whose official designation had so startled his visitor, took an interest no greater nor less than in any of the many traffic violators who expose their mentalities to his searching inquiry

Canty put T-102 through the ropes, over the jumps, across the hurdles.

To What Extent do Psychopathic Cases Contribute to Motor-Vehicle Accidents?...Weeding Out the Unfit by Specialized Analysis of Attitudes

By ANDREW R. BOONE

Y OU mush into the car ahead, dath past the red signal, send pedatrians serving for asidy as you swing the wheel hard. You must not how contributed You may not how contributed to the c

Physical examination revealed him to be normal. He stood five feet ten inches tall, weighed 190 pounds. His voice was slightly hoarse. Neurologically, he was negative; his vision was found adequate when both eyes were used, though a trifle subnormal when the eyes were tested individually. Depth perception and color vision were good. He was thoroughly familiar with the traffic laws

An inspector from the Police Department's license bureau accompanied T-102 on a driving test. He performed according to the requirements of the law, although . . . mark this! . . making turns violently, blowing his horn excessively, trying to make pedestrians and drivers move out of his way, "thus showing no consideration for the rights of others."

THIS check was by no means conclusive. It demonstrated the man's shill ity to drive, hut beyond that shilliy lay an attitude which Canty explored (curther. He took T102's psychiatric history. He asked many questions designed to hring out that attitude and reveal his level of intelligence. He studied the record Here is what Canty (cond.)

record. Here is what Canty found:
During the 15 years which T-102 had lived in Detroit, he received 287 tickets for various traffic violations. "Minor violations," explained the subject non-chalantly, as though these infractions had no significance since he had injured no one. That was only the beginning.



dany motor-car accidents are caused by thoughtlessness and a disregard of the rights of others. Carried to extremes, such irresponsibility will become "driving lunary"

We'll skip the details, and come to the important point. Canty gave T-102 an intelligence test, found him to pos sess the intelligence of a ninc-year-old child. Further, his intellectual weakness was complicated by his conviction that laws were made to beat, not to obey.

Canty finished the job, passed his conclusions along to Lowell S. Selling, M.D., clinic director, and here's what Dr. Selling wrote Judge Maher

"While this man is certainly not insane in the conventional sense, his conduct is as unpredictable and dangerous as the usual insane person's would be, for he has no more consideration of the rights of others than one who suffers from an actual serious mental disorder. We might call him a 'driving lunatic' because of this irresponsibility. The fact he has had no previous accident record is a matter of luck, and he is bound to get into serious trouble in the future if he drives. In fact, he has continued to drive although he has had no license. Finally, we consider T-102 the most dangerous man to have been examined in the last 200 cases, and, of course, could not indorse the granting of a license to him."

And, of course, Judge Maher refused T-102 a license. Which concludes our interest in T-102 as a case, but not as a symptom.

How many nne-year-old mentalities step on throttles and guide their motor cars through traffic, menacing life and property? To what extent do intoxication, emotional instability, maniae depressive psychosus, pilepsy, faulty mental attrudes in general which may be classed as insanity contribute to the appailing total of deaths and broken bodies?

No one knows the precise cause of

Alan Canty, whose work un psychotechnology largely forms the basis of the present article, is shown, at the lower left of the photograph at right, operating the reactrograph. With this device it is possible to test the reactions of drivers and hence arrive at conclusions regarding mental attitude

all accidents. because few accidents are meetigated thoroughly enough to reach the causes. Then, too, several factors usually are involved. Defects of highway and which, actions of pedestrians and drivers—these contribute. But the drurer, "defective in much or body," according to the National Safety Council, is the most important element.

How may these wholesale killings and myuries by hundreds of thousands be halted—or can they? Traffic safety drives often are accompanied by increased killings. Where, then, lies the remedy? In psychiatric surveys? Do these surveys adequately reveal the "smart alecs," the "show-offs," the lunatics—borderline and real?

"Traffic accidents largely represent a disease," according to Canty, "and we seek the cause."

Detroit is finding the answer—by measuring human aptitudes regarding motor-car operation. Here street conditions are reproduced in the laboratory, and standardized tests evolved by Dr. A. R. Lauer, of Ohio State University, Dr. Morris S. Viteles, at the University of

Pennsylvania, Dr. Harry R. De Silva, of Harvard's Bureau of Street Traffic Research, Charles S. Myers, at the National Institute of Industrial Psychology in London, and Canty bring to light some surprising facts.

One night in late June, for example. a 51-year-old man made a left turn, and, failing to straighten out on the right struck a car approaching along his left. Not much of an accident, but the police, trained to look for unusual behavor, decided to investigate carefully.

"Pretty tight, aren't you, buddy?" one policeman asked.

On the way to the station, the prisoner admitted he could "feel" the effects of a few drinks. At Judge George T. Murphy's request, Canty, put this man, now T-217, through the paces and learned he was suffering from hypertension, had an artificial left hand



and a hernia on the left side of his body.
"Extremely explosive, aggravated by
many years of chronic alcoholism,"
Canty reported. "Suffers inferiority
complex. Very dangerous."

Oddly, T-217 agreed.

"Better put me on probation for six months and take away my license before I kill somebody," he urged.

Canty accepted the recommendation, and Judge Murphy forbade the gentlepan ever again to touch the wheel of a motor car, adding: "We have no sympathy for drunk drivers."

Why revoke a man's license just because his car this another? The accident, as it happened in this case was not the underlying reason. True, the driver had been negligent; furthermore, the happening was symptomatic of perhaps a more tragic collision. Detroiters value their lives. Their judges and psychologists propose to protect them.

T-217 admittedly had had a few drinks, but T-39 was cold sober when he smashed the trunk of a car whose driver had halted for a red light. Now, T-217, remember. was 51 years old, and T-39, it developed, had barely turned

"I pulled up, but my foot must have slipped off the pedal," T-39 told the police, who didn't like his excuse, and booked him for reckless driving.

"The guy must have been talking to his girl friend," the officers reported to the desk sergeant.

T-39 faced Judge Murphy and repeated his story. "Besides," he added, "damage was only seventy bucks."

This time, perhaps. But what about his next accident, and the next? The hoy may have been entertaining his Number One Flame, but, while of average intelligence, Canty's probe revealed these additional significant facts about him.

History of venereal disease, coarse tremors of facial muscles and fingers, considerable motor incoordination, alcoholism, slightly defective vision

atconoism, siignity defective vision Canty did not stop here Perhaps some of these factors were in themselves effects, and not causes. As he proceeded with his examination he uncovered other facts of even greater bearing on that simple crash.

"ITS father," he found, "he a chronic that alcoholic, unstable and irritable. His mother obtained a divorce when he was three, and went to live with a sister who was operating a "blind pig." The boy lived in several boarding homes and was a problem child in several schools. He admits having been arrested three times for being drunk, and recently was held in the Psychopathic Ward of the Receiving Hospital after taking an overdose of barbural.

T-39 had disintegrated, and it was not entirely his own fault. What to do with him?

"Your youth and attitude," Judge Murphy told him later, "make you worthy of help."

T-39 went on probation; his license will not be returned until he demonstrates to the court's entire satisfaction that his mental and physical health make him once more fit for the high-

Traffic authorities, judges, and psychologists have no desire to diminish the number of drivers. They wan thon-catly to protect the public—you and me-by adjusting drivers with correctable defects and eliminating from the streets and highways those too severely maladjusted.

This is the reason for Detroit's Paychopathe Clinic, which is a department of the Recorder's Court. It was established for the sole purpose of examining individuals referred by various courts of the city. To it come those who are convicted of traffic felomes, and those who by their behavior subsequent to arreat lead authorities to think paychiatric examination is indicated. All have been found guilty before Carty gets them. Upon his recommendations rest their punishment and rehabilitation, if any.

If this article seems to harp on attitude, the emphasis is wholly desirable, for attitude of the driver toward the law and his fellow man holds the key to success for this newest cross between judge and detective—the psychotechnologist He never knows at the outset whether he's dealing with a temporarily instable intellect or a dangerously in same driver. Nor is he interested—officially—in what he finds.

T 398 (you will note that Canty identifies none of his subjects, for unofficially he hopes each will somehow



Arrows raised 1/4 of an inch above the surface of the road, some painted white and some black have been installed on this California highway is an endrayor to redure the state's accident rate

escape the damning implications of lunacy) seemed mild enough when picked up for speeding. His tone changed in the courtroom

"These birds," indicating the officers,
"want to get me. They've jimmed up
my speedometer. Honest, your honor,
I'm not guilty."

But in the quet of the laboratory, the 39-year-old speeder unwittingly gave up an entirely different story. Not only had he been in the hands of a psychatrist for treatment, but he was at that very moment suffering from a severe form of insanity. Crazy—and at the wheel!

No jail sentence for T-398. Eloise Hospital got him, where he will be denied all contact with the motoring public until death or medical science separates his physical body from his unfortunate mental deficiencies.

SUCH cases could be multiplied many fold were there such men as Selling and Canty on the job from Sandy Hook to San Diego. from Jacksonville to Jackson's Hole. Every community has these cases, yet so far there is only this fragmentary record of their criminally irresponsible driving.

More than 30,000 likely will perial in motor-whicle accidents in 1939—many of them vectims of men like T-102 and T-398. Make available to Canty the necessary constellation of factors upon which he builds a decision, and he'll soon tell whether John Jones. or you, or me, is a safe bet behind the steering wheel. Green a thousand Cantys, with scores of thousands of "attitudes" explored each year, and we'd have safer driving, need a hundred new hospitals for the insare-per both.



Street conditions, in model form, are reproduced in Detroit's Psychopathic Clinic, and standard tests are used to bring out facts about drivers' fitness

Research On High Pressures

In the past few years "extreme pressure" has gone out of the realm of a scientific curiosity and has become a tool in the solution of practical problems.

In spite of the fact that, until recently man was not able to develop pressures in the laboratory as high as 1,000,000 pounds per square inch, such pressures frequently occur about us in our everyday experiences. Pressures of a few hundred thousand pounds per square inch are occasionally produced in the hypoid gear in the normal operation of an automobile, in roller or hall hearings, under the wheel of a glass cutter. when the bullet of a high-powered rifle strikes a solid object, and in many other cases where two hard objects strike each other. They are, of course, confined to an extremely small space, and have s very short duration. Such extreme pressures in liquids or gases are much less common, but even gas pressures of nearly 1,000,000 pounds per square inch probably occur every day as particles of meteoric matter, traveling with a velocity of 30 miles per second, collide with the very light upper layer of the earth's atmosphere.

Recently an experiment was carried out in the high pressure laboratory of the Research Foundation of Armour Institute of Technology in which a pressure of 1,500,000 pounds per guare inch was developed. This was the highest pressure ever produced experimentally in high pressure investigations. The pressure at the centre of the earth is estimated to be about 3,200,000 atmospheres, or only 32 times as great as the maximum pressure that has been produced in the laboratory.

This increase in range of artificial pressures may clear up many puzzling questions which have formerly been considered impossible of solution. Very the control of the con

A brief survey of the work that has been studied by means of the high pressure equipment now in the high pressure laboratory of the Research Foundation of Armour Institute of Technology will serve to show the great diversified application of such investigations. A Curiosity of Science is Proving to Have Direct Practical Bearing on a Large Number of Industrial Problems . . . Examples of Promising Applications.

By THOMAS C. POULTER, Sc.D.. Ph.D. Scientific Director of the Research Foundation of Agreement Institute of Technology, Obligano

The work was started in an attempt to study a reported effect of pressure upon the chemical reaction of sulfuric acid on zinc to form zinc sulfate and diserted hydrogen. This investigation was carried to a pressure of 30,000 at-mospheres, during which it was found that the effect which we set out to study did not exist. In the course of the investigation we found many interesting things, including a little known chemical reaction of hydrogen on sulfuric acid to give hydrogen sulfide and water.

Other chemical reactions were investigated under extreme pressures, such as the reaction between sugar and water. The rate of this reaction was found to decrease with increase in pressure

From the information gamed as a result of our previous work, new pressure equipment was developed in which it was possible to carry on experiments in cylinders with glass, quartz, or dismond windows, which will withstand pressures of one half million pounds per square inch. In connection with this development many interesting phenomena were observed, such as the ability of glass or quartz windows one quarter inch hick to be bent to a radius of curvature of four inches as many as ten times before being broken.

The development of these windows made it possible to study the effect of pressure upon the manner in which a beam of light, which is vibrating in one plane, is rotated as it passes through compounds which tend to rotate this plane of vibration or polarization. This effect was to increase the rotation of all compounds studied, some of them heing increased to three fold their normal value. Both materials which rotate to the right (dextro-rotatory) and to the left (levo-rotatory) were investigated. This provides a method of studying the progress of such reactions while the materials are under pressure.

The windows also made it possible to study the phosphorescence of zinc sulfide, and it was found that the effect is to decrease the intensity of the phosphorescence by a factor of one half for a pressure of 30,000 atmospheres. It was also found that a rapid change by readded to the second of the control of the one sulfide. Aside from the intensity, the fluorescent and phosphorescent properties of zune sulfide were very little affected by extremely high pressures. It, therefore, provided a convenient method of studying the effect of extreme pressures upon the radioactive decomposition of various materials by actually observing scintillation. These measurements confirmed the negative results of similar investigations by other observers using quite different methods.

Further investigations made possible by the pressure windows were the deter mination of the effect of pressure upon the index of refraction of certain liquida. This investigation showed that the theoretical relation developed by Lorenz-Lorents for the relation between density and index of refraction holds for those substances investigated.

THE quartz windows were further tuitlized in making absorption spectra measurements of the effect of pressure upon the compressibility of the neodynium atoms at the various electron energy levels.

The effect of pressure upon living organisms has been studied, with the observation that 12,000 atmospheres are necessary to kill bacteria, but as the complexity of the living organism increases, the pressure necessary to destroy life decreases. Because of this selective effect of pressure in killing liv-ing organisms and the relation that exists between the pressure required and the size of the organism, it is possible that this may lead to developments of far reaching importance in combating certain diseases. Some small forms of marine life about one fourth inch in length, such as hydra and planaria, were found to withstand pressures of from 10,000 to 20,000 pounds per square inch without any serious damage. The effect of high pressures was to precipitate some of the colloidal constituents of the organism, and a study was made of the precipitation of other colloids, such as suffur, silver, gold, ferric hydroxide, molybdenum blue, and prussian blue. Some colloidal materials are precipitated by the comparatively low pressure of 100 atmospheres, whereas others are only slightly affected by pressures as high as 17,000 atmospheres.

THE electrode potential of the hydrogen electrode was investigated under pressures up to 30,000 atmospheres and the voltage of the Weston Standard Cell up to 12,000 atmospheres. The effect of pressure on both of these is of a lather low order of magnitude.

The effect of pressure upon the pene tration of water and numerous other liquids into glass and metal surfaces has been investigated with some very interesting results. Water was found to penetrate in considerable quantities to a depth of several millimeters into glass in only a few minutes' time The penetration of alcohol and ether is somewhat less, and such houids as paraffin oils, glycerin, and so on, penetrate scarcely at all A similar effect, but to a considerably lesser degree, was observed for the penetration of liquids into metals. The penetration of gases into metals, of course, is more rapid than that of liquid and represents a problem of considerable industrial importance, particularly in the case of penetration of hydrogen into steel whereby the tensile strength of the steel is reduced to less than half its original

The normal dissociation of steam into hydrogen and oxygen, and the subse-quent removal of the oxygen by its reaction with the metal of high-pressure steam lines, particularly under conditions where a high superheat is used. presents a problem of the utmost importance in the high-pressure, high superheat, steam installations that are being used at the present time. It has been shown that considerable quantities of hydrogen are continually escaping through the walls of the high-pressure, high superheat, steam lines, and this subject should be thoroughly investigated to determine to what extent this is affecting the tensile strength of the nietal of the steam lines. If this effect is cumulative, as is the case under the conditions of many of our experiments, it might very well become a problem of great importance in high superheat steam insulation, if not indeed a limiting factor in the industry. We have found that this effect is not only a function of the temperature and pressure, but is also affected by the composition and heat treatment of the steel. It is, therefore, a combination high pressure and metallurgical investigation.

Other fields which have been investi-



A pressure of 580,000 pounds per square inch has been developed in this cylinder (between the four large tension bolts) which contains a glass window in either end for internal observation

gated are compressibility of liquids and solids, the effect of pressure upon the viscosity of liquids, and in some cases the change of state, or even transitions from one crystalline form to another.

A brief summary of the effect of pressure upon the properties of matter will reveal some very interesting facts. The following characteristics for liquids and solids are all affected by pressure: density, volume, index of refraction, electrical conductivity, thermal conductivity, magnetic permeability, delectric constant, optical rotation, chemical reactivity, solubility, phosphoreacence, fluorescence, physical strength, specific heat, latent heat, permeability to gases and liquids, and viscosity.

If we consider all but the last two items on this list, we will see that the effect is anywhere from a small percent up to certainly less than a factor of ten.

But now let us consider the last two items. The permeability to gases and liquids may be of the order of magnitude of many thousandfold, and the coefficient of viscosity of many lubricating oils is increased by as much as

200,000,000 times their value at atmospheric pressure. Some liquids are affected comparatively little by pressures of 400,000 pounds per square inch, whereas some oils acquire a hardness between that of metallic lead and metallic copper. It is, therefore, probable that the lubricant of the future, where extreme pressures are involved, will be a liquid little affected by pressure. This will serve as a carrier for a different material which becomes sufficiently hard under pressure to serve as the lubricant. It is therefore our belief that the permeability to gases and liquids and the effect of pressure on viscosity are the two characteristics that will represent the most fruitful problems for investigation, and certainly are the two that are most likely to produce noticeable effects in industrial processes involving high pressures. Investigation of the permeability of gases and liquids has already been discussed and the viscosity investigation of lubricating oils under pressure probably represents one of the most promising investigations to be carried out in this

Noise Control

If you attend the New York World's Fair and enjoy your visit to the Perisphere, that huge spherical structure which houses "The City of Tomorrow" exhibit, you can credit your pleasure to the new science of noise control.

This Perisphere shows what a scientific attack on noise can accomplish. Without acoustical treatment, this 180-foot diameter room would be a reverberating chamber of horrors. As it is, voices, a symphony orchestra, and moving machinery are boused peaceably and you hear pleasant sounds rather than a silly symphony of noise.

Noise control is a necessity, not a fad The clatter of machines, the din of office equipment, produces deafness and nervous disorders, while the high noise level of modern civilization in all its phases lowers human efficiency and happiness. We know this to be true because controlled tests reveal that employees make fewer mistakes and produce more when their work environment is made quieter, and because the public responds quickly to noiseless products. Thanks to noise control, we enjoy automobiles which really live up to that old slogan, "No Noise But the Wind"; we go to the talkies because we can hear the actors free from the sound of film production and background disturbance; we can fly across the continent without cotton in our ears.

Industry benefits directly from the in crease in sales which follows quickly upon the silencing of a product, but that is by no means the only advantage derived from attacking noise. MachinNecessity, Not a Fad...Controlled at Source...Stopped or Damped by Scientific Design...

Improved Efficiency, Calm Nerves, Less Deafness

By PHILIP H. SMITH

ery which has been re-designed to reduce noise is often more efficient and frequently cheaper to produce than its raucous predecessor. Furthermore, the study of sound has led to the development of machines which employ sound for production control and product inspection, thereby lowering cost

The new science has evolved from many years of study into the nature of sound and its transmission. Work with the telephone, and later with radio, has been contributory because investigators treated sound as a phenomenon to be controlled in the interest of creating wanted sound and subduing

or eliminating the unwanted Out of all this has grown a fairly definite procedure for tackling all noise problems.

Designed to be as silent as possible, the fast-running, "almost human" office machine at the right is further silenced by being mounted on rubber footings. Likewise, the clatter of the wire machine below is dampened by footings which absort vibration and therefore some of the noise. Insert shows the mounting of rubber and steel

Every control problem has two phases. The first phase involves the measurement of sound. Two types of microphones are used for this: one is sensitive to velocity or particle motion, while the more commonly used is sensitive to pressure. The electrical curvuit establishes the electrical curvuit of sound which can be analyzed in terms of frequency and intensity

This first phase is known as the diagnosis. It is essential to the second phase which is the treatment. Most noise is made up of several sounds and the diagnosis seeks to sort out and identify the





varous components. Customarily, the specialist attempts to pull down the highest component and then proceeds down the scale until a level is reached which is considered satisfactory. His achievement is recorded as a lowering of decibels; that is to say, in a reduction of watts per square centimeter of acoustic power.

The engineer's skill centers largely in his ability to bridge the gap between analysis and application; in relating noises to their origin. Once he knows what offends and to what degree, he finds it relatively easy to choose between modes of treatment. Instrumentation alone will not do the job. Ears and past experience must be employed to interpret because noise control has not yet been reduced to a book science.

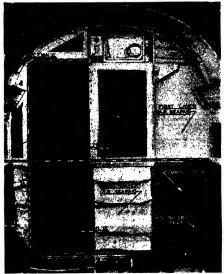
The engineer regards noise as a fact rather than as an abstraction. The elimination is warranted only when there is an irritation to the human system. He seeks, therefore, to uncover the components and reduce them to a non-rritating level. His interest is in making life more bearable, rather than in banishing noise per se.

The fact that noise is always relative and that this relation is an integral part of the control problem is well illustrated by reference to the automobile. The seasoned car owner may recall the experience of coasting with a dead engine. to become conscious suddenly of many annoying chassis and body rattles hitherto unnoticed. With the engine sputtering again, the rattles became lost in the general clatter Engineers met a similar experience when they undertook to silence automobile engines to make them what we now enjoy. When the engine was made less objectionable other noises became prominent and so treatment was carried from one unit to another to achieve an overall benefit Similarly, air-conditioning equipment suitable for city buildings has been known to be unbearable when installed in suburban dwellings where the background noises were lower

WHILE the passenger automobile illustrates the general problem of noise control it is by no means representative of details. Every noise problem tends to be unique, and to demand its own particular method of solution once it has been analyzed. The silen cing of auditoriums, for example, involves the exclusion of street noises as well as the treatment of sounds gen crated within the structure. If the entertainment sounds are to be pleasurable, the specialist proceeds to determine the timing, direction, and strength of noises and to select the proper material to subdue the unwanted sounds without impairing the quality of the voice or instrumental performance. In early days of noise control when the science was less exact, sound-proofing was often overdone, with the result that the entertainment sounds were rendered



Thick pads of glass wool next to the skin in the curved fuselage celling of a Clipper plane



Sound-proofing installation in the forward cabin wall of an airliner. Several kinds of fibrous sheets are built in. They include a coarse paper and felt

hteless, especially in radio studios. The afore-mentioned Perisphere is really a unique auditorium calling for special treatment. It has the curred callings and walls surfaced with a sound-abordent bard made of shredded wood fibers and backed by two other absorbent materials placed m alternate squares. Some eight feet behind this surface treatment, a mineral wood prod-

uct placed between the structural steel girders and lining the inner surface of the sphere's outer shell, traps whatever noises get past the inner wall and prevents reverberations from annoying the audience.

Often an important factor in the silencing of public buildings is attack upon air conditioning and operating machinery. Sometimes it is necessary to dampen blower noises, and to line air ducts and re-design outlet grilles to reduce the sound of rushing air. More and more the practice is read more the practice is re-

sorted to of suspending heavy operating machinery on rubber-in-shear to prevent the transmission of sound vibrations.

It is possible to contrast the problem of noise control in the treatment of structures by citing instances of silen cing a telephone booth and an aircraft engme test building. By studying the course of sound travel a very interesting booth has been developed which has no door and, therefore, does not get stuffy or become a steam bath on hot days. Sound which enters the open side is trapped by absorbent wall surface materials, while the exterior is treated to reflect and disburse the bombardment of unwanted noise. In the case of the aircraft test room, silencing the engine itself was out of the question as the purpose of the test was to take measurements running under normal operating conditions. Here, the building housing the engine was made as sound-proof as possible while the exhaust was carried by vertical stacks to a great height to be expelled with little annoyance to the investigators as well as the surrounding neighborhood.

Where there is motion there is apt to



be noise and thus transportation equipment of various types has been receiving a great deal of attention Recently. a silenced train was placed in operation on one of New York City's subways to demonstrate very convincingly what can be done in the way of insulating, absorbing, and otherwise dampening out noise to make travel more comfortable. Even track has been tackled from the noise elimination standpoint. In this same city, rubber tie plates have been tried out under normal operating conditions to determine the cushioning effect of placing the rails on rubber While a measure of comfort is provided for passengers by this new device, the principal advantage accrues to adjacent building structures and to rails and rolling stock. About 90 percent of vibrations is prevented from reaching the buildings, while the life of rails and rolling stock is substantially lengthened. It is a little early to forecast an overnight adoption of rubber tie plates, but there is a strong likelihood that they will come into use where the greatest damage is inflicted by impact, such as on curves and on bridges.

RUBBER suspension plays a very mortant rôle in the silencing of modern trolleys, buses, and streamlined trans. but much progress remains to emade. Noise control got its foothold in the luxury end of transportation and has still to make its real contribution to mass transportation vehicles via the road of silent design.

Apropos of rubber suspensions, a case can be cited which illustrates how easily the amateur noise controller can be led astray in his quest for silence. It is common practice to suspend heavy machinery at four points, although threeInstallation in a school of a Celotex product which effectively absorbs manufactions and echos. At right: John-Manville sound deadening material being packed into the cushioned floor chairs which are part of a special "floating" construction that efficiently controls all noises

point suspension is often more satisfactory because it insures an even distribution of weight at all times Knowing the efficacy of jubber suspension, one practitioner concluded that the more rubber the greates the absorption and placed a channel or frame of rub-

ber under a machine im place of four blocks. It failed to silence because of the sealed-in area under the machine which permitted no escape of air as the machine rose and fell minutely in operation. In short, the vibrations were transmitted to the foor acting as a dasphragm under the action of compressing and decompressing.

occompressing.

Noise control engineers have practiced long enough to avoid such mistace: they know what can and cannot be done. In early experiments with the bedough the control of the

If it is permissible to call a tank and

a submarine transportation vehicles, they can be mentioned here as examples of highly important noise control work, even though the details are lacking. The interior of a tank is a poor place for survival at best and its operation has been hampered by the terrific din which military authorities now seek to subduct. At least one European Power is hard at work eliminating the noise from submarine operation to render the vessel more immune to discovery by sound detectors in the hands of the enemy

It is now a well substantiated fact that silence can be had at less expense if built into a product, rather than by removing noise after manufacture. Offien it coats less to produce a quiet machine than to manufacture a noise on one and there are innumerable examples of noise control work which has led straight to lower production cost, more efficient operation, and larger sales of the product. One noisy element in an otherwise well silenced product may be a large obstacle toward its wide use.



Consider for the moment the case of a street car which emitted a noise like a siren. When snalyzed, it was discovered that the frequency of the sound was dentical with the number of revolutions of the ventilating fan multiplied by the number of blades. With this clue the nebre was tracked down and eliminated by allowing sufficient room for the rushing air to pass between blades and the metal outside ribs of the fan.

Outstanding among the examples of built-in silence is the modern commercial transport plane. One will recall the ploneer days of commercial Sying when only the application of cotton to one's ears made transportation bearble. Today, cotton is a surplus commodity in aviation because the plane producers called in noise engineers to check design features in their relation to noise creation and transmission. The silenced plane did not arrive overnight. The first, effort, that of trying to find a

sound-proof material to wrap around the plane, proved fruitless. Materials satsafy different acoustical needs and these had to be differentiated and evaluated as to their insulating value. More important, the sources of din had to be located and classified in the order of their importance, then tackled separately and jointly, because it was an other discovery that silencing one component accomplished little: all contribu tory sources had to be treated.

By far the worst noise offender in an airplane is the propeller, and not the engine as might be expected. Engine exhaust ranks second and engine clatter third. Improvement came by increasing the distance from the tip of the airscrew to the fuselage and designing so that baggage or utility rooms would lie in line with the propeller; likewise exhaust was led to discharge as far from the cabin as possible. Engines are, of course, sources of vibration and, to overcome some of the disagreeable effects. flexible mountings were developed. Then, to improve conditions within the plane, the floors were suspended so that they virtually floated and windows were given flexible mountings in rubber.

most every instance where the result is outstanding.

Thus far we have made no comment upon sound deadening materials. This is wholly intentional; science and technique precedes materials and their application. Acoustical materials number in the thousands. They embrace a host of fibrous substances in countless forms, felts and felt compositions, cork, plasters, different forms of rubber, various combinations of hard and porous materials, almost without end. Each has its own peculiar combination of properties and the choice for any application requires experience and judgment.

Noise control is in its infancy despite the rapid advance made within recent years. One has only to jot down a partial list of all the products which have not been silenced to reach his own estimate of the future. At the same time it would be a gross oversight not to include the utilization of sound for production control and inspection of products This is a phase and a mighty important one of the noise-control science. It promises rapid development because the few things already accomplished demonstrate a dollars-and-cents saving more

An outstanding development

for subway car noise control-

a rubber spring to be mounted

on the axles. It is constructed

in the shape of a hollow cone

with flanges inside and out,

and is split through for mount-

ing between the truck and car

Air ducts in our conditioning systems would carry the noise

of motors and blowers through

immediate and obvious than that derived from silencing noisy products.

Just as the electric eve has been focused upon productive purposes, so the electric ear has been turned toward industry. The ear is now being employed to regulate the flow of raw material to a ball mill. This device increases ball mill efficiency by 10 percent, while a similar percentage reduction has been made in power consumption. If gains are borne out consistently, the electric ear will undoubtedly come into use for the grinding of such materials as clay, limestone, ailies and cement.

AMONG the instruments developed for product inspection which base on sound for their operating principle, there is one which checks over cans of condensed milk to locate those in which a bit of solder has broken loose to create spoilage. There is another which tests for the quality of abrasive wheels. A good wheel gives off a definite note which rings for a certain length of time when it is struck, and it is quite simple to check the pitch and duration of this sound. A third device tests for gear tooth contour by the sound of gears in mesh. This last device is extremely important as providing still another means for checking gears so that the modern automobile can be operated without an annoving hum at various speeds.

This harnessing of sound opens up an entirely new field and we may expect development here to run parallel with those which endeavor to climinate or lower sound to non-irritating levels. Before noise control could be undertaken in a serious way as a specialized enterprise it had to produce tangible results at a reasonable cost. Those results have been accomplished and the time has come when the specialist comes close to saying: "I can kill so many decibels for so many dollars." This gives the go-ahead sign to industry

graphs sourcesy Boeing Aircraft Co , Celot Douglas Aircraft Co , Inc , B P Goodrie Johns Manyille Coro



an air-conditioned building were it not for the sound-absorbent lining of the ducts. in this case Airacoustic abeets

The foregoing gives but a brief list of noise control elements in modern transport design. It does serve, however, to emphasize the principle of "before" rather than "after" treatment in design, because the accomplishment has been such a large factor in abetting the progress of commercial aviation. The advantages are evident for all to appreciate who fly. There are on the market other products less striking that have been favorably influenced by the patient and thorough work of noise control engineers, notably vacuum cleaners, mechanical refrigerators, and garbage dump trucks, while a good beginning has been made with business machines of many types. It will be found that quiet has been built-in rather than achieved through noise reduction in al-



Our Galaxy Re-Measured

THE most powerful method we have for sounding the depths of space depends upon variable stars of the Copheid type. The remarkable relation between the periods and the real brightness of these stars, first detected by Miss Leavitt at Harvard, some 30 years ago, has been fully confirmed by later studies.

Measured by photographic effectthat is, in violet light—a star of this sort, with period 2½ days, is 350 times as bright as the Sun. For a period of five days the brightness is 550, for ten days it is 830, 20 days, 1500, and, for a 50-day period, 2500 times the Sun's. If then we can find the period of variation which is not so hard if we have enough photographs to work on—we know how bright the star really is; and, knowing how bright it looks, we can calculate the distance.

Useful as this relation is, we are still in ignorance of its physical cause. We have very good reason to believe that variable stars of this type are pulsating -alternately expanding and contracting -and the theory of these changes has been worked out in considerable detail But this theory depends on the laws of gravitation and of gas-pressure. It tells us that a star pulsating with a given period must be of a certain density (lower for longer periods), but places no restriction on its size. The observed fact that stars of a given period (and density) have all the same brightness. and hence the same size and the same mass, must depend in some way upon the manner in which heat is generated from atomic sources inside the stars

WE are pretty sure now that the heat is liberated evenly at the time when the star is smallest, and hottest inside, but we do not know the details. Unless the internal structure of these stars is very queer, they cainon be hot enough made to be a surfaced to the stime of the same than the same of the same

Fortunately, we do not have to wait to understand the process in order to use the facts. Were it not for one obstacle, we could map out all the nearer portion of space, up to 1,000,000 light-years or more. But there is something really in our way—great clouds of thin haze in space which weaken the light

Galactic Rotation Effects, Interstellar Absorption and Certain Dynamical Constants of the Galaxy Have Been Determined from Cepheid Variable Stars

By HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

of the stars behind them, and make them look fainter than they would otherwise appear. Many of these clouds are sharply defined, and show conspicuously against the background of the Milky Way—but there is an increasing weight of evidence that these are nonly dense portions of a vast thin fog which extends along the plane of the Milky Way to

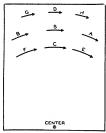


Figure 1 Effect of stellar motions

enormous distances but only a little way on each side of it

When we look at an object, such as a spreal nebula, which lies far out of the galactic plane, our line of sight soon escapes from this dust-haze and enters intergalactic space, which appears to be almost perfectly clear. But distant objects in the galactic plane are much dimmished in brightness, even though there are no obvious obscuring clouds in front of them.

Simple and convuncing proof of the existence of this absorption has recently come out of the admirable work which Dr. Joy of Mount Wilson has done in measuring the radial velocities of Cepheid variables. Since these objects can be seen at great distances, they should be particularly suited for our use in

a study of the rotation of the Galaxy.

Our more persistent readers may recall a discussion of this some months ago [December, 1937 .- Ed.] of which the main point may be repeated here. Suppose that the Milky Way is in rotation about a great mass of stars at its "Center" (Figure 1), and that the Sun S is moving in a circular orbit, at a speed represented by the arrow. Stars at A and B, ahead of it or behind it in its orbit, will be going at the same speed, and neither receding from us or approaching. A star at C, nearer the center, will be moving faster-like a planet nearer the Sun. Its motion will be crosswise, and its distance will not change: but one at E will be running away from the Sun, and receding, and one at F overtaking it, and approaching. Stars on the opposite side will be moving slower than the Sun. There will be no change of distance at D. but the Sun will run away from G, and catch up with H The net result is that stars in two opposite parts of the galactic circle will be receding and those in the intervening quadrants approaching. The greater the distance of a star from the Sun, in a given direction, the greater will be the speed of approach or recession; indeed, this will be proportional to the distance. until the latter becomes a considerable fraction of the distance to the center (when things get more complicated).

THE Sun as not moving in a precisely a circular orbit; but this is easily allowed for. For the stars in the general vicinity of the Sun—say 100 lighty-years—the differences from circular motion will serage out. Hence the motion of the Sun, relative to the general average of these stars, will represent its difference from motion in a circular orbit about the galactic center. It is fairly easy to find this motion, and to allow for

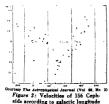
Let us now return to the Cepheid variables. Their observed velocities must be corrected for the "solar metion" just described, and also for the motion of the surface of each star, arising from its alternate expansion and contraction. To eliminate this it is necessary to make many observations of each star, distributed at different phases of the variation, so that a curve may be drawn to represent the changes in velocity—from which a true average value may be derived.

This has made Dr. Joy's work very laborious, as, on the average, a dozen or so plates were needed for each of the 156 stars on his list

When it is added that more than half these stars were fainter than the tenth magnitude, and some of them below the 14th, we may begin to realize what an enormous amount of diligent observing has gone into his results.

When the normal velocities for each star are cleared of the effects of motion of the Sun relative to its neighbors, and plotted against the galactic longitude, a very marked double oscillation is seen (Figure 2). The plot looks rather stars at very different distances, with different rotation-effects, have been combined.

If the stars are norted out according to their distances—calculated on the assumption that there is no absorption of light—it is found (Figure 3) that the nearest stars show only a small effect, and greatly exceeding the deviations for mixedual stars (which represent the differences of their motions from circular orbits). For the next group, the amplitude is great, and for the two templer groups, the rotation-effect great-



ly exceeds the individual motions of the

No more convincing proof of the galactic rotation could be desired; but there are still complications. The average distances for the four groups, calculated without absorption, come out 1700, 5000, 10400 and 20,000 light-years; the half-ranges of the effect are 10, 23, 29 and 38 kilometers per second—and by no means proportional to the distances, as the theory demands. The simplest explanation for this is that there is a general hazy absorption

of light such as has been described above. This makes the more distant stars look fainter and leads to an overestimate of their distances. By "cutand-try" methods-assuming various values for this absorption, calculating corrected distances, and seeing whether the results run in proportion to the observed rotation effects-Dr. Joy finds that a good agreement can be reached with an absorption of 0.85 magnitude per thousand parsecs, or 0m.26 in 1000 light-years. The average distances for the four groups then come out 1400. 3500. 5400 and 7500 light-years. For the nearer stars the effect is not great, hut for the last group it is very serious There can be little doubt that this result is substantially sound, for investigations based on quite different data indicate ahout the same amount of absorption.

Accepting this value, it appears that the depth to which we can study the structure of the Galaxy with the aid of Cepheid variables is limited. Even a very bright Cepheid, of period 50 days, would appear of the 16th magnitude at a distance of 20,000 light-years, and of the 19th at 30,000.

OUR only hope of finding more disobscuration appears to be not uniform, but patchy There are dense clouds in places, thinner ones elsewhere, and nearly clear regions. The value given above is a sort of general average heavily obscured regions we should not be able to see as far; and Joy notes that there are no Cepheids in his list at calculated distances greater than 4000 light-years within 20 degrees on each side of the galactic center in Sagittarius, where the obscuration is known to be heavy Even here, though, there is a chance that there may be gaps between the great clouds, which provide "windows" through which we may see some much more distant objects. A careful detailed study, region by region, is required to detect these, and promising results have been obtained at Harvard.

It is only when we look right along the galactic plane, flatwise through the absorbing haze-layer, that we get into so much trouble. Joy concludes that this layer is 300 light-years thick. Light coming in at any considerable angle to tie plane will not have a long enough path in it to be greatly weakened. This assumption of a uniform layer with sharp boundaries is again greatly oversimplified. It is almost certainly irregular in thickness and thins out gradually.

One thing which the Cepheid velocities give accurately is the direction of the center of the Galaxy—of the line S-Center in Figure 1. This is found to lie in galactic longitude 325° 3 ± 1.3—in very good agreement with other determinations. The distance of the

center is much harder to determine accurately, but the figure shows how it can be done. The point B at which a star would neither approach So rrecede from it lies on the circle BSA, so that the single BS-Center will be less than 90°. If we can determine it, and the distance SB, we can find S-Center. Using the second and third of his groups of stars (which should give the best

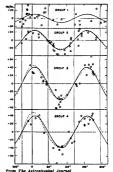


Figure 3. Rotational curves for the four star groups named in the text

values) Joy finds the distance of the center to be 38,000 and 24,000 glaves, The first value should be more accurate, so that he adopts 33,000 lightycars (1,000) parsecs) which again agrees with the results of other observers. This is so much farther away than even the remoter Cepheids that no great difference is made in the calculations, when it is taken into account. (Dashed curves, Figure 3, show results.)

When allowance is made for galactic rotation, the outstanding residual motions of the Cephelds are found to be small—averaging only 11 kilometers per second. As the circular velocity per second, heir orbits must about the galactic center is nearly 3000 kilometers per second, their orbits must be very nearly circular. The pare very nearly in one plane, also, for the average distance from the mean plane is only 200 light-years as against a probable diameter of at least 50,000.

Only one thing prevents these results from being definitive and final. The southern Milky Way, from Carina through the Southern Cross and Centaurus, is below the horizon of Mount Wilson, to that the only spectroscopic observations available in this region are those which have been made with smaller telescopes in the southern hemisphere.—
4.4 Seq. M. V. Britannic, June 30, 1939.

Cuba-Key To Manganese Problem

CUBA today holds what may be the most important single key to America's national security in time of war.

Nine years ago this weam't true Since then, American capital has developed, in Cuba, America's only nearby source of a raw material vital to our national defense—a dirty looking, sooty ore of manganese. This ore is an absolute essential for the manufacture of steel, the metal that wins wars

Attention in United States metallurgoal circles has been focused recently on our national procurement problem as regards manganese and other materials essential to industrial operation, by passage of the \$100,000,000 "stockpile" bill, signed by President Roosevelt early last June. This bill, aimed at reducing the "dangerous and costly dependence" of the United States upon forcing sources of "strategic materials," is designed to encourage development of our domestic sources.

American private enterprise has already contributed largely to solution of one aspect of the procurement problem. The Cuban-American Manganese Corporation, a subsidiary of the Freeport Sulphur Company, has developed in Cuba the world's only plant for concentrating manganese ore on a commercial scale by the flotation processwhich means that they did something that metallurgists had for years con sidered next to impossible. Direct result of this development was that Cuba, which in 1931 provided less than 1 percent of American manganese needs, last year sent us over 25 percent of our total imports for consumption.

The importance of this development may be fully realized only when considered against a background of facts regarding the properties of manganese, and the tenuousness of our foreign sources of supply. Manganese is not just one of a list of more or loss essential materials. Of all the strategic raw materials, it has been rated Number One in importance by the War Department. Furthermore, there are many grades of manganese ore, and not just any grade will do.

Mangauese is the only material which can be used economically as a de-oxidizer and de-sulfurizer in blast-furnace operations at steel mills About 14 pounds are used in making a ton of high-grade steel, and, without manganese, no atteel could be manufactured economically in this country. To be of use to

Manganese Vital in Steel Manufacture...We Have None...War Would Cut Down Imports...Cuba Now Supplies Some...Momentous American Achievement

By RICHARD B. CLARKSON

the steel industry, the manganese ore must be of "ferro grade"; that is, it must have a metallic manganese content

of about 50 percent.
Although deposits have been charted
in 20 states, these are for the most part
of such low grade in their natural state
as to be virtually useless for steel manufacture. Costs of concentration have for
years been considered prohibitive. Concentrating methods other than the flotation process were applied to American
ores during the World War, under the
spur of war-time necessity, but this
work was not conducted on an important
scale after 1918.

Since the war, we have depended for about 95 percent of our supply upon foreign sources, in countries that possess deposits from which high-grade manganese is obtained at exceedingly low labor cost—Russa, India, Afraca, and Brazil. Russis has for years been our number one supplier and, in spite of the Cuban development, still is.

As long as we reman largely dependent upon such remote sources for our supplies of manganese, we face our our supplies of manganese, we face to ment of supply with a flare-up of warm ment of supply with a flare-up of warm almost surely result in the establishment of blockades at the focal points of trade routes serving warring nations of trade routes serving warring nations.

terranean—through which pass shipments of manganese to the United States from both Russia and India.

In the light of these facts, the significance of the Cuban development may be seen as two-fold. In the first place, Cuba is only 90 miles off Key West and there is little possibility that shipments of manganese from this source could be interrupted in the event of war. In the second place, the rise of Cuba as an important source of so vital a raw material is taken by many as pointing the way to possible similar

development of our domestic sources. The Cuban-American Manganese Corporation was formed in 1932, but work preparatory to its formation began as early as 1930, when the Freeport Sulphur Company instigated petrographic studies of ore and rock formations in Cuba. This work was undertaken on samples taken from north of the town of Crasto in Oriente province, on the lower slope of the Sierra Madre Mountains.

DEFORE 1930, many attempts had been made by other concerns to concentrate the Cuban ore, but all experimenters had come to the conclusion that the ore bodies were too irregular in occurrence and too low in grade to concentrate. Fresport's preliminary investigations of the ore bodies revealed that—in their field to the north of Cristo—there existed some high-grade manease ore, varying in manganese content between 38 percent and 50 percent—a grade far too low to 20 percent—a grade far too low be used by steel manufactures.

Previous investigators, however, had confined their experiments to the conventional gravity separation method, which operates on the principle that manganese differs in specific gravity from the material with which it is combined in nature. It was discovered by



Freeport that insufficient difference existed between the mineral and the "gangue" material—ditr—from which it was to be separated, to allow efficient concentration. Other previously-attempted methods of dissolving and precipitating the ore were found to be either inefficient or prohibitively costly.

Having cleared away the deadwood of old methods, the company concentrated verge of profitable operation. It was at this point in 1928, however, that the United States-Brazil trade pact caused such a drop in the domestic price of manganese that operations at the Cuban-harrican plant were immediately suspended. A program of further research was then projected, aimed at reduction of operating costs. The result of this research was installation of the only

rign producers. The practice has been to the allow a preferential of at least 25 percent. With this as a stimulant, and with the Cuban-American development as an encourager, it is possible that the next is encourager, it is possible that the next include the product of the product of the provide for at least the greater part of our domestic manganese industry able to our domestic steel industry's needs for this material.

I N evaluating the Cuban development, and its established and potential ef-

fect on the doniestic economy of the

United States, it should be remembered

that manganese for steel is of course an

essential ingredient of peace-time indus-

trial operation. This is an age of steel

Manganese from Cuban ore pits, like the one at right, promises to solve a large part of the problem long surrounding this material which is essential in the manufacture of steel. By a flotation process developed by Americans—one step of which is shown below these ores are supplying an increasing percentage of our needs for manganese vital in steel production. And without steel, nations would perish, especially in wartime, from lack of guns, trucks, machinery, and other necessary equipment



"wet process sintering kiln" used in the Western hemisphere. Made with the help of F. L. Smidth & Co., Danish builders of metallurgical kilns, this mechanical device "agglomerates" the wet concentrate, accumulating it in casilyhandled lumps or nodules.

Development of the process was, for all practical purposes, an American undertaking, since nearly all equipment of or mine and concentrating plant was purchased from the United States, by American capital. American kas reaped and will continue to reap the benefits in preacting, and may find the development to be the salvation of its steel industry in time of war.

It is probably true that special local terrain difficulties and special difficulties of transportation may preclude the possibility of applying to the ores of the United States the exact process used in Cuba. Nevertheless, it is possible that the Cuban development may serve as an important simulant in implementing the provisions of the recently-passed "notcopile" bill—a major purpose of which is to encourage development of our domestic sources.

This bill authorizes the expendature during the next four years—of \$100,000.000 to acquire stocks of strategar saw materials which are today obtained by the United States largely from shroad. It provides, furthermore, that all purchases shall be made in accordance with the "Buy-American" act of 1933, which states that the purchasing agent may allow a reasonable price preferential to domestic producers, as opposed to for-domestic producers, as opposed to for-domestic producers, as opposed to for-

in which we live. In the past half-century, the capacity of American steel furnaces has expanded over 1000 percent. Today, steel manufacturing is a \$4,200,000,000 industry, third largest in the nation, annually paying nearly a billion dollars in salaries and wages to over 600,000 employes And, just as steel has grown in importance, so manganese imports have increased, soaring from about 250,000 tons of ore in 1930 to over 900,000 tons in 1937 There is a growing universal awareness of the importance of all raw materials in preparedness planning. The effective power of a nation is no longer determined by the extent of its territory, nor by its wealth in gold, nor even

ness of the importance of all raw materials in peparedness planning. The effective power of a nation is no longer determined by the extent of its territory, nor by its wealth in gold, nor even by its strength in armies or equipment in munitions. but rather by its capacity for continuous production of loob-uniled boots and cannot beans, tanks and rifles, ammunition and au-planes. It takes 17 men, manufacturing and distributing war naterials, to keep one man on the fighting front. And for large scale industrialization, raw material is the first essential.

The implications of America's raw materials shortage were cogenily summed up recently by T. M. Girdder, chairman of Republic Steel Corporation, who said: "God grant that this country does not become involved war, yet even if we are at peace while other nations are at war, our supplies of imported metals might be cut off for long periods. Down in Kentucky, buried in deep underground vaults, we have stored away a great pile of gold. The me might come when we would gladly give all of that gold for a pile of deep reartely-needed manganese."

If another M-Das should dawn in America. Cuba will be ready with at least a partial solution to the crisis; the plant production can be stepped up between the condition of the

all subsequent effort on the development of an altogether new system—the flotation method, which "washes" the ore free of impurities.

The method which was finally worked out and is used today at the Cuban-American plant, is a complex one. It involves grinding the ore to "unlock" the manganese oxide from the gangue material; ditution (enormous quantities of water are used in the floatation process); use of reagents for frothing and floating the manganese and for alimediapersing; flooculating; and sintering, which diminates water from the hydrous wide mineral.

Numerous mechanical difficulties were encountered from the beginning, but by February, 1935, the plant was on the

Eyes That See Through Atoms:

(In Two Parts-Part Two)

WHEN the spectroscopist burns a substance in an electric arc to force it to emit light, the molecules of which it is composed are torn asunder. These molecules consist, of course, merely of groups of atoms clinging together in definite patterns. When vitamins or hormones or other such computations or hormones or other such computations or hormones or other such computations.

plex materials are studied, it is the molecules themselves which are of interest, rather than their constituent atoms. Though such materials would be destroyed if burned, fortunately they can be studied with the spectro scope by an entirely different method from the onc used for detecting atomsa method which leaves them entirely undamaged. If a material is at all transparent, light can be sent through it, and waves of certain lengths will be absorbed by its molecules The spectrograph can then be used to obtain information about the molecules by analyzing, not the light which it receives, but that which is missing because absorbed before it enters the spectrograph

Vitamin A, for example, has been found to absorb strongly any light waves which are slightly shorter than violet waves. Therefore, instead of feeding cod-liver oil to rats for weeks to discover how much vitamin A a given sample contains, the standard procedure now is merely to seend a beam of ultra-violet light through the oil, and measure with a spectograph of the procedure now is merely to seend a beam of ultra-violet light through the oil, and measure with a spectograph of the procedure of t

the amount of light of wavelength 3290 angstroms which is absorbed by a layer of oil of measured thickness. Care must be taken to dissolve from the cod-liver oil any non-vitamin material which might absorb light waves of the same length, but such offending impurities can easily be eliminated by mixing chemicals with the oil, which change them to seap.

Analyzing a transparent or translucent substance by studying the light it Spectroscopic Analysis the Supersensitive . . . In Vitamin Research the Spectroscope Short-Circuits the Overworked Rat . . . The X-Ray Spectrograph

By GEORGE RUSSELL HARRISON, Ph.D.

Professor of Experimental Physics and Director of the Research
Laboratory of Physics at the Massachusett Institute of Technology



Couriesy Adam Nilser, Lid A portion of a typical spectrogram as used to determine the Vitamin-A content of cod-liver oil. Reference figures at top and hottom indicate wavelengths in angaroms, while the tier of absorption spectra showe difference in light absorption for varying thicknesses of oil, as may be seen by shoosing some prominent line or feature and running it downward.

absorbs is particularly convenient because the material is not destroyed, and the method is quick, clean, simple, and accurate. The two questions which any such analysis must answer are "What substances are present?" and "How much is there of each?" Light absorption measurements answer the second question very definitely. It is estimated that a layer of material only five atoms thick can, in many cases, be detected by the light it absorbs. By combining a microscope with a spectroscope a speck of vanadium only 100 atoms long by 00 atoms brod by five atoms thick has, in microscope with spectroscope is pecked of vanadium only 100 atoms brot bick has

been observed Ability to detect such a clump of matter, containing only 50,000 atoms, weighing a billionth of a billionth as much as a dime, stamps this method as one of the most sensitive available.

ALL life ultimately de-pends on absorption of light, for it is the absorption of sunlight by the green leaves of plants which keeps the plant and animal worlds alive. Biologists have long used the spectroscope in their efforts to learn how the chlorophyll of green leaves manages to capture sunlight, and, with its aid, store in the leaf carbon from the air as cellulose, starch, and sugar. Many a leaf, green or brown or vellow, has been held before the slit of a spectrograph and had its inner structure plumbed with light in an effort to unravel the secrets of chlorophyll and carotin and other complex molecules on which life depends

In the ultra-short-wave region of the spectrum lies a broad band of waves entirely untouched except by the pioneering surveys of spectroscopists studying the

appetrum for its own sake. Such useful applications of these waves as there may be, and there are probably many, must wait until further experiments have been performed designed to perfect ways of handling those delicate rays. No one has yet succeeded in finding a solid material which is transparent to light waves benter than one fourth as long as those we call violet and longer than X rays, and which could be used for windows to allow light to enter and leave experimental apparatus. Thus far hydrogen and helium are the only materials which the ultra-short light waves

^{*}Copyright 1939, by the Author From the boo "Atoms in Action The World of Creative Physics, by George Russell Harrison (Shortly to be publishe by William Morrow and Co)

have been found able to penetrate, and though windows have been made of such tenuous gases, it is something of a trick to do this.

In the realm of the still shorter X rays-waves similar to light, but less than one thousandth as long-almost all matter becomes relatively transparent. Windows of many types are thus available, but the technic of handling X rays is still very crude; we have no lenses to bend them, no mirrors to reflect them, no microscopes to sec with them. In spite of these lacks, two powerful methods of using X rays have been discovered. The first is to take ordinary shadow pictures with them, such as have revolutionized niedicine and surgery during the past 40 years. The second is to send the X rays through a special type of spectrograph

Revealing as is the glimpse through fosh or metal which an X-ray shadow picture gives, it is crade compared with that obtained by means of a spectrograph. Then the glimpse is into the very atoms of matter themselves—even farther into the hearts of these atoms than is possible with an ordinary spectrograph.

N 1912 Dr Max von Laue had the In 1912 Dr. Max von Land brilliant idea that a crystal, such as rocksalt or diamond, might separate X rays into beams of similar wavelength much as an ordinary diffraction grating separates light into its colors. The diffraction grating consists of thou-sands of parallel lines traced on a mirror; the crystal, argued von Laue, consists of millions of parallel lines of stoms, very close together, and perhaps these closely spaced lines are just what is needed to sort out the short-waved X rays. Experiments carried out at von Laue's suggestion showed that his idea was a good one. When a narrow beam of X rays was sent through a crystal, bright and dark spots appeared on a photographic film held behind the crystal, and the positions of these were found to depend on the different wavelengths in the X-ray beam, and on the arrangement of the atoms in the crystal. Sir William Bragg and Professor W. L. Bragg soon were able to arrange the crystal in a spectrograph so that clear, sharp, spectrum lines were obtained with X rays, entirely similar to those produced when visible or ultra-violet light is sent through an ordinary spectrograph.

If X rays are ent through a piece of metal, the small crystals of which it is composed can be studied with the X-ray spectrograph. This use of X rays has particular application in the heat trestment of steel. In one foundry it had slavsy been found necessary to keep certain metal parts for six hours in a furance at high temperature, to bring them to the proper strength and hardness. Then the arrangement of crystals in the



oursey recasology resides
The world's largest vacuum spectrograph, at the Massachusetts Institute of Technology. Since six is one one to light wave, shorter than show 2000 unsutrans.

nology. Since air is opaque to light waves shorter than about 2000 angstromall air must be pumped from the light source, the spectrograph, and the camera if such rays are to be photographed. Note vacuum pump and valve air car

metal was studied, and the realmement of the atoms and crystals during heat treatment was followed with an X-ray spectrograph. As a result it became possible to work out theoretically a special short course of treatment lasting only half an hour, and on trial this proved to give better results than the longer treatment, at one fifth the cost.

Peces of metal which undergo great stress, like amplane propellers, usually show changes in their nutrial structure a considerable time before they are acidy to break. Propellers are almost always X rayed by the shadow method, to discover internal flaws, but they should also be studied from time to time with the X-ray spectrascope to insure that their atoms show no signs of wanting to let go of each other.

How well a piece of cloth will wear depends on the quality of the fibers of which it is weven, and how strong and flexible these fibers will be depends greatly on the character of the molecules of which they are composed. The X-ray spectrograph can be used to look right down through the fiber structure directly into the arrangement of atoms in these molecules, and sometimes shows that improved arrangements of atoms would make better molecules, hence sturder fibers, hence stronger cloth.

In cotton, wool, and asbestos fibers the molecules are found to consist of long strings of atoms lying side by side; here are substances respectively of vegetable, animal, and mineral origin which are similar in molecular and in outer form. Mica is composed of molecules which form broad flat crystalline plates arranged in layers which are held together so loosely that they can be split apart without difficulty. In diamond, on the other land, carbon atoms hold

strongly to each other in three dimersions to form crystals which cannot be torn or split, and hence produce the hardest substance known. But change the arrangement of these diamond atoms ever so little and groups of them begin to slip apart, the crystal structure changes, and instead of the lard, abrasive diamond, we have graphite, one of the softest and most slippery solids known.

If a piece of rubber is held between an X-ray tube and an X-ray peetrngraph, the spectrum shows that so long as the rubber remains unstretched the molecules in it are arranged helter-skelter with no semblance of order, but when the rubber is stretched, long chains of molecules appear, which contact and expand like cooled springs. The unusual ability of rubber to atretch and then return to its original shape can be traced directly to the molecules of which it is composed.

About lubrication the X-ray spectregraph gives important information, for it shows that greases and oils contain long molecules which slide over one another in layers.

The physicist has been able to conribute the telephone, the radio, the motion picture, television, and a dozen other adjuncts of civilization, only by using the powerful tools with which he has armed himself for the investigation of nature. Among these tools the spectrograph is outstanding, ever ready to yield new information on the structures of atoms, on the arrangements of the molecules which these atoms form, on the multitudes of substances which can be produced from these molecules, and hence on many of the activities of men, machines, and material university.

Two Elements For One

THE Fifth Washington Conference on Theoretical Physics was sitting in solemn conclave when the news broke. Professor Nils Bohr of Princeton and Professor Enrico Fermi of Columbia rose to open the meeting with an account of some research going on in a Berlin laboratory

Professors Bohr and Fermi are Nobel Prize winners both, and their names are as well known to scientists as Toscaninni's is to music lovers. The Conference therefore expected something extra special. They weren't disappointed.

It was January 26, 1939. A few weeks before, at the Kaiser Wilhelm Institute in Berlin, Dr. Otto Hahn, a distinguished German physicsh, had obtained an uterly unexpected result from some more less routine experiments. Following the original example of Professor Fern. Dr. Hahn and his co-worker, F Strassmann, had for many months been bomberding uranium with neutrons and studying the debris left by this atomic designs and studying the debris left by this atomic studying the debris left by the atomic studying the control of the studying the debris left by the atomic studying the control of the studying th

It would not have surprised them at In fact, they had done so before, or thought they had done so before, or thought they had Radium and uranium are near neighbors in the table of elements, and it is nothing new for scientists to transform one element into another close to it in weight and electric charge.

But it was news, and big news, to discover barium among the debris barium, which is only a little more than half as heavy as uranium II meant that the neutron bullets had succeeded not merely in knocking a few chips off the old block, but in blowing the whole atom assunder with a terrific explosion.

The theoretical and practical import of Hahn's discovery may not be immediately obvious to the laymen. The article will attempt to interpret its significance in later paragraphs. But on the scientists, the new had the same effect as the tidings of gold in California had on the Forty-niners. They flew to their laboratories to find the treasure for themselves.

A few insiders had already jumped the gun ahead of the Conference and of the rest who learned of the discovery through the newspapers. In Copenhagen, Dr O. R. Frisch and Professor Lise Meitner, who had previously wecking with Hahn on the same problem, had vernfied his results ten days earlier. A group of Columbia University physicists. including Fermi, independently thought up and carried out a similar experiment The Most Important Scientific Discovery of the Present Year is also the Biggest Explosion in Atomic History... Splitting the Uranium Atom

By JEAN HARRINGTON

by January 25, the day before the Conference. By the time the meeting wound up its affairs January 28, three more laboratories—at the Carnege Institution of Washington, Johns Hopkins, and the University of California—jomed the horus of confirmation. In a word, Hahn was right. Uranium, and thorum, too throrum is also among the heavest elements), had been split in two by neutron hombardment

THE phenomenon was quickly dubbed rauclear fission," and in the months ensuing since its discovery, nuclear fission has grabbed the spotlight from the "heavy electron" sensation of 1937-8 Dozens of the world's top-flight physicists have been buy as bees, roaming the clover of a new field of research.

The first task of the investigators was to get a picture of what had happened. Dr. Frisch and Miss Meitner promptly supplied a pretty good one.

The nucleus of an element, they point of out, is now thought of as an aggregation of protons and neutrons packed to gether into an inconceivably small space. The number of protons, or units space. The number of protons, or units of positive electric charge, accounts for the chemical behavior of the element. Neutrons are units of weight and have no charge. Together the neutrons and protons make up the mass of the nucleus.

The simplest nucleus is the single proton belonging to the lightest element, hydrogen. Going up the atomic scale, adding one proton and a varying number of neutrons for each successive element, we arrive at last at uranium. This heaviest of elements is invariably characterized by its 92 protons; in its commonest form it contains 146 neutrons as well, giving it a total weight of 236. Two other forms, weighing 253 and 234, also occur in small quantities. These are called the three natural isotopes of uranium, and are distinguished by the shorthand symbols U.W. U.W. and U.W.

Now all the known elements heavier than mercury—that is, thallium, lead, bismuth, polonium, radon, radium, actinium, thorium, protectinium, and uranium—have isotopes that are naturally radioactive. Their nuclei are so complicated that occasionally one will spontaneously simplify itself by shooting off a particle.

We can picture the process nicely if

We can picture the process nicely if we imagine for a moment that the radioactive nucleus is like a drop of water, composed of many molecules. One of the molecules near the surface somehow acquires a little more energy than its fellows and evaporates.

The stage is now set to return to Dr. Frusch and Miss Meitimer, whom we left some paragraphs ago. Their conception of the nuclear fission process continues of the nuclear fission process continues on the analogy of the drop of water. Suppose the H₂O molecules are volently agutated by a source of energy outside the drop. Instead of evaporating graduually, the drop splits in two. Similarly, a ruranium nucleus, stimulated by the impact of a neutron bullet, may divide into two smaller nuclei of routhly creunal size.

These fragments are in themselves unstable. and quickly dismitegrate to form still other nuclei. In fact, a whole series of transmutations generally follows the faston of uranium or thorium. Since Hahn first found barium among the products, he and other investigators have identified antimony, tellurium, nodine, xenon, caesium, and lanthanum in one group; bromine, krypton, rubidium, strontium, and yttrium in another, with many possible additions.

The explanation is simple enough. The original fragments contain too many neutrons in relation to their proton content, and must get rid of them to achieve a stable form. One of two things happens. The nucleus may simply expel a whole neutron, reducing its weight by a unit. Or one of the neutrons may be converted into a proton plus a negative electron inside the nucleus, which promptly ejects the electron. In the latter case, the nucleus remains approximately the same weight but acquires an additional positive charge. thus becoming a chemically different element. Experiments have proved that both these types of disintegration actual-ly do take place.

No one knows yet whether the same two original products are always formed when uranium divides, or what they are But if one of the fragments is barium, with 56 protons, the other must have 92 minus 56, or 36, protons, which would make it an isotope of the gas krypton.

If the barium tries to stabilize itself by emitting an electron, it becomes a lanthanum isotope, which may in turn convert itself into cerium by electron emission. The krypton also disintegrates in the same way, successively be-

coming rubidium, strontium, and perhaps yttrium and zirconium. We can show these chain reactions by a formula where the subscripts represent the number of protons of the products:

$$Ba_{5a} \rightarrow La_{57} \rightarrow Ce_{58}$$

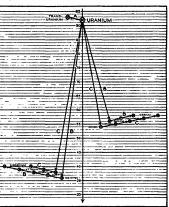
 $Kr_{5a} \rightarrow Rb_{57} \rightarrow Sr_{48} \rightarrow$

Y₃₀ → Zr₄₀
Again, if the two original fragments are strontium and xenon instead of barium and krypton, we may have the following chain reactions:

$$\begin{array}{l} Sr_{ss} \rightarrow Y_{ss} \rightarrow Zr_{40} \\ Xe_{s4} \rightarrow Cs_{s5} \rightarrow Ba_{s6} \rightarrow La_{s7} \\ \rightarrow Ce_{s8} \end{array}$$

In a discovery like this in the realm of pure science. it is always easier to see the theoretical importance than to find a practical application. The fission of uranium has provided a field day for the physicists who like to take atoms apart and find out what makes them tick. It adds a new chapter to their knowledge of the nucleus-the forces that hold it together, the collective behavior of its constituent parts, its reac-tion "under fire," its des-

In addition, it clears up a mystery of long standing, dealing with elements heavier than uranum. When, in 1934. Fermi began his experiments with uranium, he soon found that negative electrons were always emitted under neutron bombardment. We know now that they are usually the products of the chain reactions just described; but at that time nuclear fassion was not even dreamed of. Fermi naturally concluded that the uranium nucleus captured the neutron, converted it into a proton, and excelled an electron.

Here, then, was a supposedly new element with 39 protons, unknown to nature. Moreover, this new element seemed to emit another electron to form another new neucleus of 94 protons. These were called "transuranie" elements, and up until lately they were a headache to the numerous investigators who worked on them. The latter kept finding more and more transuranies; and when they studied their chemical properties they found inexplicable variations. Last No-weake, past a few weeke before Dr. Hahn stumbled on the real secret, he announced that he had found at least 16 different kinds of nuclei resulting from neutron bombardment of uranium. Some of them, indeed, behaved chemically like barium, lanthamum, and other light elements, but they were thought to be isometically the sound of


Three of the reactions that are possible when uranium is bombarded by neutrons. Each borisontal line represents as chemical element containing the indicated number of protons. A represents the formation of transuranium. B shows the split of uranium into bariam and krypton, with the chain reaction that follows it. G represents the division into zenon and strontium followed by its own subsequent chair reaction

topes or isomers of heavier elements such as radium. (Isomers are nuclei having the same total weight but different chemical properties. Isotopes have the same proton content but varying total weights.)

When the announcement of nuclear fission came, it was immediately realized that the electrons were not in general emitted by the uranum nucleus itself but by its lighter fragments. The mystery of "transuranic elements" was practically solved. It does seen, however, that a neutron bluelt occasionally fails to give its target quite enough energy to divide; the uranium isotope disintegrates by electron emission and really does form a new element with 93 protons. But one such problem child is far better than 16.

So much for the theoretical significance of nuclear fission, far-reaching though it is. It is pretty hard to amass as much weight on the practical side of the balance. But our imaginations are immediately seized by the terrific amount of energy liberated when a single uranum nucleus explodes. The two fragments fly apart activated by some 200,000,000 electron volts—a total far greater than that associated with any other atomic phenomenon except cosmic Favs.

The tabloids love to write of blowing

up the world with a gram of matter, and it's not such a sensational idea as one might think. Even a tiny mass has an enormous potential of energy if it could but be freed. It is just such a conversion of mass into energy that speeds the fasion fragments on their way.

The weight of any nucleus is never quite equal to the aum of its individual protons and neutrons. A small proportion of their mass, called the "packing fraction" or "mass defect." is somehow transformed into the force that holds the nucleus together. Otherwise the positively charged protons would all repel each other and scatter in every direction.

The packing fraction for uranium is, because of its large number of particles, greater than that for the simpler elements into which it divides. This difference in energy is released with the two fassion fragments.

OF course, 200,000,000 volts is an astounding energy compared with the size of the bodies which possess it. But for practical

purposes it is absurdly small, amounting only to about three ten thousandths of an erg. In more everyday terms, it would take 25,000 billion fassions per second to produce one horsepower—figures which dwarf even the national budget. The very best a laboratory can do so far is produce a few hundreds per second.

If atom smashing could be made more efficient, power production by means of nuclear fission would not be beyond the realms of possibility. But under present conditions, the process is as inefficient as removing the sand from a beach a grain at a time. Or, more graphically, it is like shooting with buckshot at a netwood of beads strung yards apart. The size of the target is comparable with the size of the projectile, the empty space between targets is enormous compared with the diameter of either, the stream of bullets cannot be well controlled or aimed, and therefore it is much more probable that a neutron projectile will fly past a uranium nucleus than to score a direct hit and be captured. In fact the chances are thousands to one against fission taking place.

Neutrons have proved themselves more efficient atom-busters, however, than other projectiles like protons or alpha particles, which are positively charged and hence repelled by the positive nuclei. To get a stream of neutrons, a preliminary bombardment must take place. One common method employs the radioactive gas radon, which spontaneously emits alpha particles (helium nuclei with double charge and mass four). The alpha particles are allowed to fall on a sheet of beryllium, where they join with the beryllium nuclei to form carbon plus neutrons. The reaction is shown by the formula.

 $Be_4^0 + He_2^4 \rightarrow C_6^{12} \rightarrow C_6^{12} + n_0^1$ where the superscripts are the atomic

weights and the subscripts the charge. The stream of positive particles from the cyclotron may also be used to bombard beryllium and thus produce neutrons. The high energy and great number of cyclotron particles make them more efficient neutron makers than the natural radio-alpha particles

Once created, the neutron beam is directed against a uranum target. The products are studied in various ways, if the investigators want to find the energy of the fragments, the target is placed in an inouzation chamber, falled with a gas at low pressure. The fragments ryp through the gas atoms, disrupting their outer electron structure to form ions. The gas sions are drawn to a wire where they constitute a tiny electric current; and the magnitude of this current gives a clue to the energy of the fission products.

If the experimenters want the range of the particles—that is, the distance they travel before their kinetic energy is all used up—they may choose a Wilson cloud chamber which automatically photographs the track of ions the nucleus leaves behind it.

If they want to know the number of fissions occurring in a given time, they have an electric counter at their command, based on the same principle as the lonization chamber. A modification of the same instrument is used to look for electrons or neutrons emitted in the fission process or in the chain reactions that follow.

The problem of identifying the products as a non-what different one, and is complicated by the large number of celements which may be formed. Here the debris is collected on a sheet of Cellophane or paper placed close to the uranium target. Each variety of isotope on the sheet has a definite rate of disintegration—it may be anywhere from a fraction of a second to several days—and this time is characteristic of the clement to which the isotope belongs.

To measure this period of decay, the collecting paper is placed near an electric counter. If the activity of one product decays to half its original value in 87 minutes, for example, that product is immediately known as an asotope of barium, Ba 122, which is known from other experiments to have a characteristic "half life" of 87 minutes. The difficulty of this method of identification is, of course, in separating the half-lives when two or more elements are decaying.



Steroscopic cloud chamber photograph showing tracks of two heavy fragments receiling in opposite discretions from a uranium nucleus struck by a neutron. The uranium is on a colloidon film (one of the broad, bright horizontal lines). The fragment tracks are fainter and fragment tracks are fainter and lower end of the track resulted from a collision of one fragment with a gas atom in the cloud chamber. The double picture is obtained by photographing the chamber amultaneously from two points of use, to get three-dimensional perspective, and the properties of the collision of the c

together, and also in classifying a halflife belonging to an isotope previously unknown.

Another method of studying the products is to perform the experiment under water, then analyze the water chemically. Suppose we suspect that a few nuclei of radioactive lanthanum are present. This is too small a quantity to separate directly. But if a larger amount of a stable lanthanum compound is added to the water, both stable and unstable lanthanum atoms can be precipitated out. If this precipitate is then shown to be radioactive, we have proved our suspicion was correct. Similarly the water can be tested for radioactive barium by adding a stable barium compound, and so on.

STILL a third attack on the problem of identification has been made by Philip Abelson at the University of Galifornia. He had been studying the natural X rays from the supposed "transurance elements"; and put on the right track by the discovery of nuclear fassion, he quickly showed that these X rays had

wavelengths characteristic of iodine and tellurium.

Research along all these lines is proceeding at breakneck speed. Experiments similar to those with uranium have been performed on thorium (Th 20) with similar results, except that only fast neutrons are effective splitting the thorium nucleus, while both fast and slow work well on uranium. Other heavy elements, such as gold and tungsten, show some slight tendency to undergo fission

Fermi and others have been trying to determine which of the three uranum sotopes are involved, and how the procres is related to the speed of the neutron projectiles. Duke University scientists are investigating gamma radations connected with fission, and the University of California is piling up data in all branches of the research. Bohr at Princeton. Solomo in Paris, and many another are concerning themselves chiefly with theory.

Irème Curse and P. Savitch, who were responsible for much of the ground work enabling Hahn to identify the products of liss fission experiments, have been carrying on the classification work in Paris. Joliot, as well as groups of physicists at Columbia, the Carnege Institution, and Cambridge University, have concentrated on the study of secondary neutrons emitted at the moment of fission and matter reactions of fission and matter reactions.

The latter problem brungs up an in-teresting and rather disturbing aspect of the case. These secondary neutrons constitute a fresh supply of "bullets" produce new hissions. Thus well are faced with a vicious circle, with one explosion esting off auchter, and energy being continuously and cumulatively released. It is probable that a sufficiently large mass of uranium would be explosive if its atoms once got well started dividing. As a matter of fact, the scientiats are pretty nervous over the dangerous forces they are unleashing, and are hurriedly devising means to control them.

It may or may not be significant that, since early spring, no accounts of research on nuclear fission have been heard from Germany—not even from discoverer Hahn. It is not unlikely that the German government, spotting a potentially powerful weapon of war, has imposed military secrecy on all recent German investigations. A large concentration of isotope 255, subjected to neutron bombardment, might conceivably blow up all London or Paris.

It has been impossible, even in this long article, to mention all the thousand sapects of this fascinating phenomenon, or name many of the able contributors to the sum of information amassed since last January. But the fact remains that unclear fission is the most important scientific discovery of the year, and holds who knows what promise for the future.

PRESERVED IN PLASTICS

TWO methods of preserving indefinitely in their natural colors such agricultural specimens as leaves flowers, fruits seeds, ineets, and other abbiological material have been developed; who chemists of the United States Depart ment of Agriculture. The processes, while supplementing each other, have different fields of application—one for dred and the other for fresh material

In the method studied by Dr. Charles, E. Sando, specimens are suspended and embedded in methacrylate, a crystal-clear plastic. In this process, the specimens must be dehydrated to prevent moisture from clouding the glass-like plastic material. They may be an-drired or dehydrated by use of alcohol or ether

Grains or seeds, insects, or anything that does not lose its color or shape with drying, may be preserved by this method. Once the plastic sets, it can be machined and polished so that the specimen may be viewed from any angle without distortion.





Modern plastics are used to do by intent what the resins that turned into amber did by accident millenia ago—to preserve insects and plant products in full color and natural form. At left and right are specimens embedded in clear plastic



In the second method, specimens are not immersed in plasties but are treated to toughen tissues and set the natural color. At right a spray of peach blossom is lifted from water-removing syrup after being refrierated the proper many planted temporarily between sheets of thin cellulous acetter film and hung up (see left) to cure for a number of weeks. Complete drhydration is accomplished in a drying cabine.



The other method, developed by G. R. Fescanden, is a chemical process for treating fresh plant material in such a way as to toughen the tisuues and set the natural color. The natural beauty of flowers, or the exact appearance of entire healthy or diseased leaves, can be preserved by immerision in specially formulated water-removing yrups. Each plant species requires an individual treatment which has to be worked out from seven general types of formulaes. Specimens preserved by this new



The curing completed, the specimen loses lit temporary film covering and is mounted on a gless plate in a water-reddent, reshouse compound, reddent, reddent, reshouse compound, right) is then placed over it for protection. It is finally added to the collection (at left) which is being kept for observation to determine keeping qualities of the specimens. If they keep well, the process will prove very valuable as a means of making records for study, research and exhibition



method are sealed between sheets of cellulose film.

Due to the expected permanence of specimens preserved by either method, excellent records of both healthy and abnormal plants and insects may be made available for research and study,

Although numerous specimens have been prepared by both methods, there are a number of difficulties to be overcome before the final methods can be released for general use.

HIGH BLOOD PRESSURE

WHEN Sir Marc Armand Ruffer made his medical study of ancient mummies found in Nubis he reposted that many of these worthies had suffered from hardening of the arteries. Dr. R. H. Hoffman, commenting on this his "Struggle for Health," sad it was natural to assume that the ancient Nubians had high blood pressure.

Yet, he observed, they did not amoke. Supposedly they did not drink hard liquor, overact meat take too much or too little exercise. They did not hive the hurried, bustling, frensied lite of modern times. Syphilis was presumably then unknown also. Yet many modern doctors believe these things cause high blood pressure and hardening of the

In the Archives of Internal Medicane for July, 1930, you will find on interesting study by Drs. Walter C. Alvares and L. L. Stanley of 6000 princeners and 4.00 prison guards. The guards had higher blood pressure than the prisoners. The prisoners were both more calm and less obese than the guards. Possibly nervous excitement entered the picture here. The guards' blood pressure was taken when they came to apply for the job, presumably somewhat excited. The prisoners, unworried and calm, would lead to have lower blood pressure.

It was found also that the bloodpressure level did not rise with age. It was affected little if any by habits of dissipation, by the use of tobacco, alcohol, or drugs, or by veneral infection. Cool weather alightly raised the blood pressure abent high blood pressure appeared to be a matter of heredity and "nerves." Even the impassive Chinese usually develops higher blood pressure when he comes to buelling America.

BUT what is "high" blood pressure? What might be high for me might, all things considered, be normal for you. In 1928 Dr. Herman O. Mosenthal delared it was quite difficult to distinguals between normal and high blood pressure by making a single test. The patient must rest and be under close observation for some time.

There are several types of high blood pressure (hypertension) too, some mild and almost harmless, others not so harmless. Patients with a benign type of the ill return to normal blood pressure after a little rest.

Dr. Mosenthal, mentioned above, also tells of curing one woman's high blood pressure (at least for the time) by preVarious are the Possible Causes of this Ill, but Worry and Nervous Excitement Probably are Large Factors...Calm Rest the Best Cure...Loaf, Loaf, Loaf

By T. SWANN HARDING

scribing freedom from community committee work. This was after she had unsuccessfully taken two sanitarium rest cures and a prolonged trip South, and

had had a major surgical operation
The relationship that should exist between blood pressure and age, contrary
to much lay opinion, remains unsettled.
Dr. Temple Gray told the British Hunterian Society in 1929 that the expres-



Apprehension when the blood pressure is taken may actually cause the pressure to rise abnormally

sion, "A man is as old as his arterice,"
had done more harm than any other
medical statement. He said some people
attain advanced age with their arteries
in seemingly hopeless condition; others
die young with apparently healthy
arteries. He claimed to have seen persons in apparent health with extremely
high blood pressures. Other doctors say
women can withstand such hypertension
well but never men.

Some physicians speak of a "lowblood-pressure type." It consists of artistic persons who suffer from leasitude and an inability to do intellectual work. They come to doctors much earlier than the high-blood-pressure type.

the high-blood-pressure type.
Others speak of racial high blood pressure and admonish us to adopt a vegetarian diet because the Chinese and the East Indians have low blood pressures. But the Eakimos also have relatively low blood pressure and no undue

affliction with kidney trouble, yet they eat only meat. What part does diet play in producing high blood pressure?

Dr. Mossail and his associates reported upon stensive studies of applicants for insurance in The Journal of the American Medical Association for Aprilla, 1937. They wrote: "People with hypertension on not habitually eat more protein or more salt than normal persons. There is no evidence to show that a low protein diet followed by a hypertensive patient, will materially reduce the blood pressure provided there is no amenia."

WOMEN, it was found, tend to adopt that the distribution of the sure do not follow this trend. Neither the salt not the fluid intake affect the blood pressure. Alware has shown in his studies also that, though women are as a whole more prone to constipation than men, men have higher blood pressure. In general, constipation and low blood pressure go together.

There is, then, no average normal blood pressure for persons of a certain age or weight. Each individual must be considered as an individual. The question is: Is this specific blood pressure high for this particular individual at this time?

In an editorial review for the Journal of Nutrition, in July, 1932, Dr. Fritz Bischoff pretty thoroughly showed that there is no evidence that diet has anything directly to do with kidney and blood vessel changes. Why, then, do high-blood-pressure sufferers go on diets? Thirty-odd years ago, when high blood pressure was discovered, it was thought to be due to the kidney disease called nephritis and to the loss of clasticity in the arterial walls called arteriosclerosis. These ideas continue to hang over, though it is now known that primary kidney disease is rare and arterial hardening usually moderate. The dietary restrictions came in with these old ideas. Time has proved most of them to be silly and unnecessary. Even restrictions against exercise have been removed, provided the exercise be in moderation. Above all, the sufferers must avoid stress and strain, for it has repeatedly been shown that, in some, a little rest lowers blood pressures almost miraculously.

Salt is often denied high-blood-pressure sufferers, perhaps for insufficient reason. The best medical authorities now agree that, within ordinary limitations, the salt intake does not affect blood pressure. Prolonged investigation of 11 patients was published in Archives of Internal Medicine for October, 1929, for example. Sometimes these people got as much as an ounce of salt a day, sometimes only a fifteenth of an ounce or so. This was done after an initial period of rest in bed on a good diet for from ten days to two weeks. Occasionally salt was injected into the veins of the subsects in considerable quantity, but their blood pressures remained unaffected.

Low-protein diets came in with the theory that kidney disease and high blood pressure were related. Today, the very assumption that long-continued excretion of the digestive end-products of excess meat consumed will irreparably injure the kidneys, is questioned More over, even sufferers from degenerative kidney disease must have a minimum of protein or they will start to digest their own tissues. If high blood pressure is uncomplicated by such kidney degeneration the meat tabu seems unwarranted The diet has been proved to have very little to do with directly causing kidney, heart, and blood-vessel ailments.

WHAT about other conditions assotiated in the popular mind with high blood pressure? Constipation often accompanies low blood pressure. Obesity tends to promote high blood pressure and is bad for its sufferers.

The death rate of those who suffer from high blood pressure in acute forms is very high. These deaths occur from three general causes, heart failure occebral degeneration being commonest, some form of kidney failure more rare However, the death rate of those with only moderately high blood pressure is about that of normals.

There is a tendency for nervous people and neurotics to have hypertension. Acute infections and intestinal auto-intoxication—assuming the latter exists, which those who appear to know most now deny—do not seem to increase the blood pressure.

Thus, in The Journal of the American Medical Association, September 20, 1990, we find a doctor claiming to have gotten excellent results on 200 patients by using biamuth subnitrate. But in the same journal for February 13, 1932, Dr. David Ayman reported his complete in-ability to get positive results by pre-scribing this drug for from three to nine months in treating 15 high-blood-presuments in treating 15 high-blood-presuments in treating 15 high-blood-presuments in treating 15 high-blood-presuments.



Traditionally, metropolitan life with the strennous excitement of its stock exchanges and intensive life conduces to high blood pressure but a comparable degree of nervous tension can be and often is developed (for reason) on the farm

sure patients. Indeed, Dr. Ayman began to think that this drug and perhaps all other has the form of the perhaps all other has been been as the surface of the treatment used, the investigator always claimed to produce partial or complete relief from the annoying sympose of high blood pressure. Moderate or marked drop in the pressure was always asid to follow. Yet the symptomatic relief was often out of all proportion to the fall in blood pressure, while the blood pressure often fell without relief of the patient's symptoms.

The various investigators had used a wide variety of rest cures, low-salt dieta low-protein diets, and regimens, as well as treatments with heat, the application of radium to the skull, watermelon extract, and all standard drugs used in hypertension. Complete failure was seldom or never reported. Yet there was no cure for high blood pressure! So Dr. Ayman decided to try on 40 unselected sufferers from high blood pressure a treatment that he was sure could not only not aid them but would lack ali effect He used a few drops of dilute hydrochloric acid in water. This at least tasted like a drug and it was enthusiastically recommended when given. The results were miraculous. There was definite improvement in symptoms in 32 or 33 cases! Dr. Ayman wrote: "The symptoms associated with uncomplicated essential hypertension may frequently be relieved by the suggestion inherent in any seriously and enthusiastically prescribed drug or method of therapy. This is the probable explanation of many successes reported in the

past."

Dr. Ayman also found that two weeks' rest abed worked wonders. He found wide variations in the blood pressure taking place without any effort to treat it at all. Obviously, relaxation was most beneficial, as Dr. Mosenthal said in 1928

and as Dr. Arthur S. Grainger told the American Medical Association in July, 1929.

A year or so ago, Dr. H. C. Gram, of Denmark, tried all the most commonly recommended drugs or regimens for hypertension. He found that rest in bed and freedom from worry did more than all else. If the patient was dieted, then the diet got the credit. If the patient was drugged, the drug got the credit rest should have had. If the patient was simply rested, the results were usually as beneficial. Hence the fall of blood pressure under medical care seemed often half-mythical. The first measurement of the blood pressure also is an alarming event calculated to run it up. Hence the gradual fall after "treatment" is often natural but is credited to the treatment.

THE best treatment probably involves televing the conditions in the environment that aggravate a rise in blood pressure. This means: Seek to displace an excitable and to adopt a calm attude. Deall things in moderation. Limit social obligations. Stop worrying, Remember that spontaneous remiseons often occur, that no diet is proved beneficial, that some sufferers resist every recommended regimen. No drug cures, hence take no patent medicines or drug hence take no patent medicines or drug the care of a competent oblyvician.

It is not wise for every sufferer to try arbitrarily to reduce his blood pressure to an assumed normal. High blood pressure is often a benign, compensatory mechanism. One has to learn to abide it. Each patient can be assisted by his doctor to attain an individual comfort level suited to his needs.

High blood pressure has been called the disease of American life, so cultivate the spirit of leisure, loaf more, dream



Conducted by F. D. Mc HUGH

TO DETERMINE MOISTURE CONTENT OF GASES

MOISTURE is an elusive agent—all-detect, difficult to elumnate or control. When there is moisture in supposedly dry annealing gases, high-carbon steel decarburizes and becomes unsatisfactory for



Dew point, and hence moisture content, of gas being read directly

many uses. Razor blades made from it have poor edges; automobile and airplane gears do not hold up in service

To help eliminate this handrap, General Electric engineers have deused a convenient, portable dew-point potentiometer for determining the moisture content of gases. This is done by measuring the "dew point," or temperature at which moisture will condense from a sample of the gas.

A small stream of the gas is conducted through a compartment of the instrument. The mosture condenses on a thin, metallic mirrow which is connected to a thermocouple and then to an indicating instrument. An operator regulates the flow of a cooling medium, usually earbon dioxide, until algabit and condensation of mosture on condensation of mosture on the condensation of the cond

The instrument is expected to prove of special value in steel mills for measuring the moisture content of annealing gases;

Contributing Editor

In charge, Daniel Guggenheim School of Aeronautics, New York University

also in chemical plants, gas plants, industrial and research laboratories, and in abop tests generally where the mosture content of gases must be known for testing or control purpose. The device weight 16 pounds and is carried in a case 14½ inches long, 8% inches wide, and 6½ inches long.

RING GEARS CAST CENTRIFUGALLY

E XPERIMENTAL work in casting gear hounced by the Ford Motor Company just over a year ago, has been wholly successful, and centrifugally-usy gears now are in regular production

Greater strength, lighter weight, and faster production are the principal ad vantages of the gears made by the new method, according to R. H. McCarnell, Ford metallurgist. By using sand cores in the die, undercuts can be made which would be impossible in a conventional forging, and this saves weight and metal.

Still more important, however, is the

greater strength of these gears made by centrifugal casting Etched sections show the reason I some forgings, times of metal flow are parallel to lines of greatest stress Because of absence of all flow lines in the centrifugal castings, this condition does not exist. The metal is equally strong in all directions

The amplicity of the centrifugal method is especially notworthy. The dies, which are made of a special low carbon steel, are mounted in units of 18 on a turntable Each die begins to spin as it approaches the two initials of the metal to two initials of the metal to two initials of the metal to boldidy, and then stops turning in time for the operator to remove the hot blank and prepare the die for the next casting

SEALING PLATINUM TO PYREX

A SATISFACTORY scal between plati num and Pyrex glass, for use in the construction of chemical and other scientific apparatus, has been developed by Edward Wichers and C. P. Saylor of the Chemistry Division of the Bureau of Standards

The general problem of joining metals and glasses has been studied by many investigators, but the fact that the thermal expansions of platinum and glass are so different has always caused trouble. Thus, when a platinum wire or rod is coated



Turntable on which gears are centrifugally cast in 18 dies

with hot glass, subsequent cooling will erack the glass or pull it loose from the metal. This difficulty has been surmounted by using a seamless tube of platinum instead of a wire or rod. If the walls of the tube are thin as compared with its length (a ratio of about 1 to 12), the shrinkage forces are not great enough to crack the glass internally or to pull the metal away from it

The mechanical principles governing the platinum-Pyrex seals can also be applied to other metal-glass seals of the tubular type. They are simple to construct, and do not require any unusual apparatus or extra-ordinary skill in glass blowing.

GAS MASK FOR OXYGEN INHALATION

AN invention which promises great ability to save lives and restore health

to suffering patients recently was demon strated by a group of Mayo Clinic physi cians at a meeting of the American Med ical Association It is a new gas mask for ical Association II is a new gas mask for giving oxygen efficiently and economically One of the famous Mayo brothers, the late Dr. C. W. Mayo, and its inventors, Drs. Walter M. Boothby, W. R. Lovelace II, and A H Bulbulian, described its promising medical uses to the assembled doctors

One patient, desperately ill with rheumatic heart disease, began to improve immediately when he was given 100 percent oxygen with the new apparatus, although he had heen expected to die. The treatment was not a cure, but an aid to the patient's fight to recover.

Patients suffering with gas gaugrene and tetanus or lockiaw have been helped to recovery by oxygen given with this new type of mask. The recovery in these cases is did to the fact that both of these ailments are caused by germs of the kind that cannot live in an atmosphere that contains oxygen

The mask is also being used to give oxy gen to patients in shock or collapse following injury or surgical operation, in cases of abdominal distension, for headaches fol





Although are welding has been used to fahricate the steel frames of numerous Atthough are welding man seen used to santener the step instance of nature of the residences, the platial home shown in the illustration above is the most imposing example to date of this type of construction. Built at Wichita Falls, Texas, this 12-room residence contains 96,000 pounds of steel framework, welded throughout by the shielded are process

lowing or injections into the brain for diagnosis of brain tumors, for migraine, and for a number of lung disorders. The mask liss also been installed on an airline for use of pilots and passengers threatened by oxygen-lack at high altitudes

The reason the new apparatus is funding such a wide field of usefulness is becauit can be used in the patient's home as well as in large, well-equipped hospitals and be cause it reduces enormously the cost of oxy-



Patients suffering from many types of diseases are relieved by in-halation of oxygen, or an oxygenhelium mixture as shown above. through a newly developed mask. In the drawing at the left, note that the mask covers only the nose, leav-

gen treatment. The cost of giving oxygen by oxygen tents, the method used hefore invention of the new mask, is from \$12 to \$25 a day. This has prevented the use of oxygen except in very few cases, chiefly severely ill pneumonia patients. With the new apparatus the cost of the oxygen should average only \$5 to \$8 a day, Dr Boothby stated

The reduction in price, made possible by the efficiency of the apparatus, will enable doctors to use helium quite generally in the treatment of asthma. Until relatively recently, Dr. Boothhy pointed out, helium was never used except for the most severe asthma cases, because of the high cost, With the new apparatus, both helium and oxygen can be used, starting with a mixture of oxygen and helium and, as the putient gets better, increasing the proportion of the less expensive oxygen till the patient is getting all oxygen - - Science Service

BLACK ELECTROPLATING

DEEP black deposits, suitable for automobile hardware, business machines, flashlight cases, and the like, may now be applied by electroplating, according to Du Pont chemists The solution used con tains ammouium molyklate, nickel sulfate, and boric acid. It is said that the process offers attractive possibilities, heing superior to black mokel plating and other similar black coating processes.

REMEMBER 'EM'

THERE have been more than 4000 makes of automobiles since the first ear propelled by an internal combustion engine appeared in France in 1868!

HIGHER VITAMIN CONTENT IN WHITE BREAD

LOAF of white bread which has the vitamin-B1 content of a whole-wheat loaf, some five times as much as ordinary hat, some we times as much as ordinary white bread, was predicted to the Massa-chusetts Institute of Technology food con-ference recently by Charles Frey, Alfred Schultz, and Lawrence Atkin, all of the Fleischmann Laboratories.

Vitamin B., or thiamin, is an important factor in nutrition but it is not stored in the body to any significant extent and thus must be contained in basic foods. Cereal products, mainstay of the national diet. are suitable for this but these products. especially bread, have been increasingly deprived of their natural vitaniin content in recent years.

The problem of restoring this loss, some times as great as 93 percent, has been tried along many lines, but the latest



A Douglas DC4 in flight

and most practical employs a new yeast. This yeast contains enough thismin to produce a loaf of white bread with the vitamin content of a whole wheat loaf but without any loss of palatableness Although made by a new process, the yeast offers no new technical problems since its baking prop-erties have not been altered. Possibility of such a loaf at a low cost-increase would be a boon to low-income groups, it is declared .- Science Service.

ACTION OF LATEX ON POLISHED ALUMINUM

VILMS of rubber, applied in the form of latex, are sometimes used as a means of protecting the polished surfaces of metallic mirrors and similar articles from scratches and dust while in storage and during ship ment. When ordinary commercial latex is applied to polished aluminum, however, a bluish discoloration is produced which re

mains when the film of rubber is stripped off Tests made at the National Bureau of Standards indicated that the discoloration was produced, not by the rubber, but by ammonia which is almost universally employed as a preservative for latex When the ammonia is removed, latex no longer discolors aluminum. Ammonia-free later preserved by the addition of the requisite mount of pure formaldehyde is likewise without action on aluminum

A FLEET OF DC-4's

UITE recently the writer had the pleasure of visiting the new Douglas DC-4 at Newark Airport. No matter how blasé one may be, the new airliner gives one a thrill by its size, its superlative finish, and its innumerable modern devices and accessories. It is not at all surprising to learn that W. A. Patterson, President of United Air Lines, has decided to purchase a fleet of six of the new DC-4's, at a cost of \$500,000 each, for use in transcontinental sleeper traffic The decision to purchase six ships was based on a careful estimate of the number of airplanes required to maintain adequate coast-to-coast aleeper service Analysis of the airline itself, backed by the estimates of independent market research groups, showed definitely that there would be sufficient traffic to warrant this bold move This year, for example, transcontinental business is running 32 percent ahead of last year's business.

While we have reported the DC-4 already in these columns, it is interesting to pre-sent the final specifications in brief, with the changes which the airline has saked for and obtained.

The passenger cabin is supercharged to a pressure equivalent to that of 8000 feet above sea-level when the plane is actually flying at 15,000 feet altitude. The produc tion type airplane will have a gross weight of 66,500 pounds. Maximum speed will be 237 miles per hour; cruising speed using 74 percent of rated power, will be 210 miles hour Range at 191 nules per hour, with 42 passengers and 3000 pounds of mail. will be 1425 miles or approximately one half the air distance across the United States The eight fuel tanks will carry 2050 gallons of gasoline Wing span will be 138 feet 3 inches, and overall length will be 97 feet 7 inches.

Cabin accommodations will be liberal The floor-to-ceiling distance will be 7 1/2 feet and the inside width more than 10 feet As a day plane, the DC-4 will have accom modations for 42 people. As a sleeper, there will be berths for 32, with double lower berths on each side of the aisle, and upper singles

Crew will consist of a captain, a first officer and a flight engineer, plus a steward and a stewardess. A K.

AIRLINE TO HELP THE PRIVATE FLIER

T is frequently claimed that the airline operators are inimical to the private flier, and have been responsible for the legislation which limits use of the airways by the private operator But surely there must be some way of preventing hindrance to scheduled operation by irregular private operation, and in general the transport people are most friendly to the itinerants. United Air Lines announces that the company will help the private owner in many ways: by furnishing weather information at all its stations; by providing haugar space at a number of airports, by selling gasoline and oil wherever such service is helpful; by providing mechanic service wherever such service is helpful and permissible. Nothing could be more indicative of friendly co-operation -- A. K.

WHY ALLOYS ARE NOT PERFECT

T is accepted, at least theoretically, that all atoms in a metal would line up in perfectly ordered arrays like millions of dice which had been carefully atacked on top of one another, provided the metal could be frozen at absolute zero 459.72 degrees

slow zero, Fahrenheit-the point at which all gases would solidify and all molecular motion would cease. But there just isn't any place on earth as cold as that. Consequently, whenever two or more kinds of oms are mixed, they arrange themselves in a more or less disordered fashion, bein a more or less disordered rashion, be-cause of motion caused by the heat. The result is an aggregation of jumbled groups of crystals, analogous to millions of dice dumped helter-skelter in a box.

FREEZE METAL PARTS FOR EXPANSION FITS

BY utilizing the extremely low tempera-tures available with a mixture of Solox and dry-ice, a new method for cold-shrink-ing metal parts for "expansion fits" eliminates both the expensive equipment and adverse chemical effects associated with previous brine techniques.

Dry-ice is solid carbon dioxide at a tem-perature of -109 degrees, Fabrenheit, which, in subliming, absorbs approximately 247 B.T.U. per pound Solox is a propri-etary alcohol-type solvent and is favored for this application not only because it remains liquid at the low temperatures but

also because of its non-corrosive properties.

A mixture of dry-ice and Solox will produce a temperature of -97 degrees, Fahren-heit, which is considered suitable for shrinking internal parts larger than 9 or 10 inches in diameter. The part to be shrunk is immersed in the Solox, and pieces of dryice are added to keep the mixture "boiling (giving off carbon dioxide) until the part is sufficiently cooled to produce the maximum shrinkage - Solvent News.

'GIRO DELIVERS

MAIL ON ROOF

T is 25 minutes truck running time from the Camden Airport, New Jersey, to the Philadelphia Post Office at 30th and Market Streets, A Kellett KD-113 Autogiro makes the trip by air in five or six minutes and shuttles back and forth from the Airport to the roof of the Post Office five times daily, carrying a full load of mail each time. Eastern Air Lines, which contracted for this service, receives \$3.86 for each mile fle



Taking off from a post office roof

One of our photographs above John Miller, vetera jiro pilot, and now a captain in the service of Eastern Air, taking of the root after a ran of less than 150 feet. The service has proved a complete success, and other cities such a Chicago, Milwaukee, Atlanta, St. Louis, Detroit, and Los Angeles are subviding the problems and are seeking to establish similar autogino mail ferries. Certainly its application in such work is a remarkable tribute to the utility of the "giro."

of the 'giro.

The Kellett KD-113 is the only government-licensed, wingless, direct-control autogiro. Tilting of the 'giro axis replaces allerons and elevator, and the small rudder



The 'giro shuttle mail service saves 20 minutes over truck time

is only used for abrupi maneuvers. The ship is a one-place model with closed cockpli, and a large forward mail compariment. With a gross weight of 2250 pounds, 150 pounds of mail are carried and top specis 103 miles per hour with a 225-horsepower Jacobs engine.—A. K.

AIRCRAFT AS AN

INVESTMENT

RAWSON LLOYD, of Aeronautical Se curity Research Corporation, writing in "Flying Facts," gives ten reasons for buying aircraft stocks Larger air forces sre being organized in all countries; unfilled orders amount to \$250,000,000; huge surcraft orders of \$175,000,000 are to be placed by the Army and Navy during the year; Great Britain and France want to buy another \$100,000,000 worth of our aircraft; more efficient production has in-creased profit margins 37 percent; contractors on Navy orders are now allowed 12 percent profit instead of 10 percent; passenger air traffic has risen 28 percent for first five months of this year; plant expansion has been conservative; labor is not yet unionized; stocks are selling on a low price-tures-earnings ratio. Even though these views come from the supposedly dangerous neighborhood of Wall Street, they must be regarded as reasonable.-A. K.

SEAPLANES CAN USE LAND AIRPORTS

AT least it would appear that sesplanes A can alight on lead, from the exploits of Al Bennett at commercial airplane demonstration given by the Aviston Country Clan of Holesville, Long Island. Mr. Bennett uses a standard Fiper Cab powered with a Chappen noter and fitted with Lead floats. The only departure from 'texnderm' was in the fitting of a steel strip are "was in the fitting of a steel strip."

screwed on the outside of the float keels. Yet Captain Bennett was able to land on the field, taxi, and take-off, without any sign of damage or even wear. Apparently seaplane floats have sufficient resiliency in themselves to take up the shock of landing.—A.K.

SENSITIVE

A CURRENT-detecting device so sensitive that it will measure the electricity earried by one electron traveling down a wire every five minutes, was recently described by Dr. J. S. Allen, of the University of Minnesota. The best previous device measures 20 electrons per second.

DROWNING TAKES

ITS SHARE

A PPROXIMATELY 7500 persons
drowned in 1938, and almost exactly
50 percent of them did it during just three
months: June, July, and August.

So says the National Safety Council in its 1939 statistical yearbook, Accident Facts. About 5000 of the total occurred while the

Two of every five drowning victims (both male and female) were under 20 years of

But listen to this, men. Five of every six drowning victims were men and boys.

ALUMINUM LUGGAGE

STYLED for the skyway, and as trin and modern as the transcontinental airliners began as the transcontinental airliners began a property of the state of the stat

Carcilly designed in every detail, the stamped shells are heat-treated to provide strength, and finished in the patented natural Alumilite finish to promote an attractive and durable surface. The interior of the women's cases is done in tich silk, with handy, removable dress hangers, rubber-lined commetic and bottle pockets, and a zipper-closung jewerty pocket. All models of the



Moisture-proof, light-weight luggage

Halliburton cases are equipped with rubber seal gaskets to protect the contents from monsture and dust. They have been subjected to submersion and artificial dust storm tests without the slightest damage to their contents. Because they are sealed surtight against changes in atmospheric pressure when closed, high altitudes will not "pop" the stoppers in containers of liquids carried in them.

RESIN CEMENT AND HEATLESS CASTING

PLASTIC

TWO interesting and important reams which have been named (buck-bet No. 1 and No. 2 have been announced by The Marblette Corporation Quick-set resins are liquid phenol-formaldelyde condensation products which are caused to harden without heat and pressure by the addition of an accelerating agent.

Quick-Set ream No. 1, when used as an

Quick-Set resun No 1, when used as an adhesive, forms an insoluble, infusuble, transparent joint of tremendous strength. It is used for joining Lucite, Plezuglass, Marblette, wood, leather, casein and cellulose plastics, Formica, pressure molded plastics, and other materials.

Other uses include wood lamination and

Other uses include wood lamination and impregnation, varnish, paper and cloth lamination.

As the hardening of this cement is strictly a chemical reaction, air-drying is not neces-



Out of its element, yet this seaplane landed and took off from the ground

sary for this material will set in the absence

Quick-Set resin No. 2, obtainable in black and ivory, is used for producing castings in rubber (latex), lead, and glass ds. After casting, this resin will harden in 24 to 48 hours without the aid of heat or pressure

COLOR DETERMINER

AN apparatus which assures absolutely correct determination of colors at any time of day, irrespective of the surround-ing sources of light, has been constructed by Dr. Tryggve Johansson, of Upsala University, in Sweden.

The machine, which is somewhat larger than an ordinary typewriter, produces an unvarying "mid-day light," by which is unvarying "mid-day light," by which is meant a light corresponding to that obtaining around noon on an overcast day This result is arrived at by using electric lampa equipped with special filters, by means of which a correct composition of light is achieved. The color tester also ex cludes all outer light sources, so that no sort of disturbing light is admitted. The samples to be compared—for example, a couple of pieces of cloth—are illuminated at an angle of 45 degrees from two opposite directions, and the observer is forced by the construction of the apparatus to studthe samples at right angles Through this arrangement, no luster or shadow effects appear on the objects, which is often the e if these are lighted from one side only -Holger Lundbergh.

SHAKES HANDS WITH SHADOW

THE newest addition to the Ceneral Electric "House of Magic" at the New York World's Fair enables W A. Gluesing. director of the show, to say goodbye to his shadow, walk off the stage, and actually leave it behind. And the audience seems to get the biggest surprise when he site down in front of a curtain, gets up while his shadow remains sitting, and then shakes hands with his own slindow

The screen on which the shadow is cast as made of a phosphorescent material. The screen stores up the light which it receives from a powerful spotlight and continues to glow after the light bas been turned off.

And so, when Mr. Gluesing stands or sits in front of the screen, all of it is "charged" with light except the part obscured by his shadow life turns off the house lights, walks away, and all of the screen glows except the part which received no light because of his shadow.

Given a strong enough light, the screen will continue to glow for as long as 10



. . With his own shadow

minutes. The shadow can be wiped out and brought back again by turning on and off the red light of neon lamps. This is off the red light of neon lamps This is the screen, and the phosphorescent light given off by the screen cannot be seen in the intense red light of the neon lamps

MOTORING EYE HEALTH FOR 1940

ADVANCE information that health is heig given important consideration in the design of 1940 model automobiles. along with mechanical perfection, comfort and safety was given recently at a meeting sponsored by Fisher Body division of Gen eral Motors Corporation at the Labliey Owens-Ford plants in Toledo Those at tending the meeting learned that better visibility through laminated safety plate glass is to be stressed by several manufac tmers as a factor for eye health and reduc tion of nervous fatigue

Dr. A. H. Ryan, Chicago research seren tist, demonstrated how polished plate glass transmits true images, whereas objects seen through sheet glass sometimes appear distorted.

"The distortion of images seen through aheet glass in a moving automobile is a major cause of eye-strain and consequent

nervous fatigue," Dr. Ryan said. "In tests we have found that three hours of driving surrounded by sheet glass causes a 62 per-cent greater loss in visual efficiency than looking through polished plate glass. We also have found that people blink oftener when looking through aheet glass and that they can read faster through plate

"These findings indicate that plate glass and the clear view it allows provide greater safety on the highway, which will be recognized as an important factor when it is remembered that approximately 25 percent of all accidenta result from faulty vis

Dr Ryan described automobile driving as healthful exercise for the eyes, "provided it is done under proper conditions."

"Driving gives the eyes an opportunity for long-range gazing-a desirable change from the constant close work of office and factory But the eyes should he allowed to see the world as it really is, not as a carrenture." Dr Rvan declared

WONDER DRUG

THE new chemical remedies of the Prontosil-sulfanilamide-sulfapyridine group are now being used to treat no less than 33 com-mon disease conditions. They seem valueless, however, in the treatment of influenza and colds.

COFFEE PLASTIC

NEW plastic, developed by the H. S. Polin Laboratory of Research in Physics, is unique, particularly from the standpoint of use in South America, in that it is made wholly from the green coffee bean and requires no additional raw materials. Coffee-plastic manufacture will be a highly self-contained industry, because the coffee provides its own chemical plasticizers and catalysis, and its own filler material Its by-products, furthermore, are sufficiently valuable in themselves to defray much of the cost of production.

The new coffee plastic can be produced n a thermo-setting or a thermo-plastic form. It can be produced in green, red, mahogany, lirown, yellow, and ebony hlack merely by the chemical development of its own coloring materials, in which the green coffee bean is unusually rich. (One of its by-





Distortion, caused by looking through safety sheet glass (left), and the clear view through safety plate glass

product fields will be that of vegetable dves and chemical color indicators.) It can be made in varying degrees of hardness and resiliency according to the use for which it is intended. It can be molded, drilled, machined, sawed, and polished, and it can be produced with a wear-resistance superior to wood, cork, or rubber, and comparable with the best grade of linoleum. The thermosetting material can he produced with a compressive resistance of 8000 to 12,000 pounds per square inch, has good dielectric strength at low electrical frequencies, very alight water-absorption, and good resistance to weak acids, fruit juices, alkalis, oils, ketones, and other chemicals, and complete fisme-conductivity resistance. It is odorless and tasteless, and it can be molded at pressures from 2000 to 5000 pounds per square

mAn important by-product of coffee-plasur manufacture is coffee oil Thus oil is rich in chemicals, contains vitamin D, and is suitable for a cooking oil and as a mixing oil for paints. It contains fertilizer and abecterial-growth segrances, and can be used in insecticades, medicines, soaps, and lotons. Other hyroducis are an emulalying agent and a chemical for forming coltons, both valuable to clienuss and chemotics, both valuable to clienuss and chemof course, coffee is already well known. Concerning the cost of manufacture, a

Concerning the cost of manufacture, a bag of coffee containing 132 pounds, which it would cost the government an appreciable amount to destroy, can produce 40 square feet of plastic ½-inch thick, and approximately 1.25 gallons of coffer oil. The manufacturing process involves no unfamiliar machinery or special handling.

RUBBER TIRE INDUSTRIAL CLUTCH

THE same engineering principle that I today is preventing thousands of motorcars from skidding on wet and slippery pavements has made possible a new type



of mechanical clutch that has great promise

of wide industrial application. When the multi-made treat of the Central Dual-10 and Dual-10 metor-car treat specificated, it was proved that, under braking pressure, the many narrow vanes or risks of rubber equirmed into a serpentine form and clung to the road surface with a degree of adhesion never before thought possible. Adhesion being the principal job of a clutch, no matter where it may be used, it-was only a step from the multi-wased tire to the Airfack rubber multi-wased tire to the Airfack rubber.



ground coffee after oil extraction; the extraction product; the reacted coffee plastic compound; and pellets produced by molding the reacted compound

clutch, the multi-vaned surface of which clings to steel with twice the friction coefficient of asbestos or other conventional clutch lining.

The Ardler rubber clutch, which is shown in accompanying illustration, already has replaced multiple disk and other place clutches in various insustations, with complete success. It has the advantage over the conventional clutch in heigh much inspire, as well, having only three of four pass compased with 75 to 100 pieces in the conventional clutch. The Ardler clutch well-disk self-adjusting while other clutches are

Two distinct types of lining are used, on both the expanding and constricting types of Airflex clutches. When excessive



Above. Details of the rubher tire clutch. Left: An installation of the new clutch in an oil-well rig

alippage is encountered and where loads are to be picked up gradually, the use of friction lining is recommended. When the plain rubber squeegee-tread is used, a reasonable amount of slippage can be toerated if the engagements are not too fre-

The clutches are given special treatment to prevent disintegration by oil fumes. A special rotary seal has been developed to deliver air to the clutch, either by entering the shaft at the end or by a straddle-type

PAINT REMOVER

E XPERIMENTATION with solvents and combinations of chemicals to make a milder paint remover resulted in a recently announced product called Presto. The remover contains no sloohol or caustic so-

lutions but is a combination of seven chemicals and, it is claimed, requires only five or ten minutes to work. The manufacturer also states that Presto seldom requires a second application, will not harm bristles on brushes, raise the grain of wood, or burn through.

Three grades are available; Grade A for fine finishes and delicate woods, AA for general use, and AAA for any finish on metals

PROBOSCIS

LITTLE things do count—heavily at times. Consider, for example, the mosquito's stinger, or proboscis. That pleasant little thing weighs just 0.0000006 of an ounce.

SILVER STEEL

POSSIBILITY of a broad extension of The marine uses of 18-8 stainless steel alloys is suggested by a patent recently granted on protection of the steel against seawater corresion by addition of minute amounts of silver to the alloys, reports The Industrial Bulletin of Arthur D. Little, Inc. The peculiar corrosive properties of seawater have in the past heen a serious, unsolved problem for stainless steel. If a portion of a stainless steel plate is covered hy, say a barnacle, the difference in oxygen concentration near the exposed and unexposed surfaces will set up an electrical potential favoring the formation of chlorides of the metals in the alloy. Since these chlorides are soluble, they wash away, leaving the surface exposed for further attack. Thus a sub-microscopic pit forms and, as it deepens, the difference in oxygen concentration between the pit and the body of the metal increases and accelerates the corresion within the pit. Ultimately the interior is honeycomhed with such pits, although the surface may appear entirely unmarred; and the steel becomes subject to sudden and complete failure, almost

without warning.

A solution to this problem, recently worked out by Professor R. S. Williams and to I seem to I see

quately dispersed, but these are the most popular of the stainless steels.

Many advantages other than corrosion

stance are claimed for the silver alloys. resistance are claimed for the suver amoys. Probably most important, since stainless steel is now considered unsuitable for many nece requiring high heat conductivity, is the reported increase of 26 percent in therconductivity on adding only 0.14 percent silver. Other advantages include provement in the case of machining and ability to take a higher polish. A very uni-form, highly polished surface in itself inhibits corrosion, since it makes inception of electrolytic activity difficult.

MUELCE

MORE than one third the distance around the earth at the equator—8870 miles—is the distance traveled annually by the average American passenger car

TORTUBE MACHINE THROWS 2600-Pound Punches

SCIENCE recently added a new punishment rack to its terture chamber—a 600-pound agony maker aimed at survival of only the strongest steel hlades for use in eam turhines. Built in the Westinghouse Research Lab

oratories at East Ptttshurgh, the novel machine subjects test parts to a concentrated dose of the hrutal pummelling which full-scale parts must withstand inside a turbine.

The weaklings, those parts that are faulty in design, literally fall to pieces, but the sturdy metal martyrs can "take" as many as 10,000,000 heatings, and that's enough to guarantee them life eternal, for all practical purposes, in the production of electric power.

These 10,000,000 blows are delivered in approximately 277 hours at the rate of 600 a minute, according to T. F. Hengstenberg,



research engineer in the mechanics division, who designed the machine.

A motor-driven flywheel throws the punch es at the test piece with a force of 2600 pounds behind every blow. Every time the flywheei turns it pushes a heavy spring to snap a steel lever up against the six-inch metal sample.

These metailic hiows, Mr. Hengstenberg explains, simulate the force of steam rushing against hiades in a turbine with a pressure of about 800 pounds to the square inch.

Simultaneously, the test piece is immersed in a steam hath inside an electric furnace at a constant temperature of 850 degrees, Fahrenheit, identical with the temperature inside a steam turbine at which the steel parts glow a cherry red. To duplicate the often travel around their shafts at speeds exceeding 789 miles an hour, the machine pulls the test piece upward with a force of 9000 pounds by means of levers and springs attached to dead weights.

COMMON RAW MATERIALS GIVE IMPORTANT CHEMICALS

THE world's most important industrial chemicals are made from a small group of mineral raw materials, although the production of a single chemical may require an amazingly large number of other chemi-

cais, processes, and raw materials

If the chemist were given three wishes, as in the fairy tale, he would nick these groups of raw materials: 1, coal, petroieum, and natural gas; 2, suifur and suifide ores; 3, salt, hrines, and sea water. These, with limestone, air, and water are most frequently used in manufacturing our chemical

Drs. R. N Keller and T. T. Quirke at the University of Iliinois have been looking into the source of 150 important industrial chemicals, ranging alphahetically from acetamilide to zinc sulfate. They can he traced back to only 34 raw materials.

Consider ammonia, for example. It and the materials used in its manufacture include ammonia liquors, nitrogen, hy-



Above: Adjusting the "punching " of the machine that tortures teel blades for steam turhines until they fracture as shown at left

drogen, calcium cyanamide, catalysts and catalyst supports, peat, bones, animal ref-use, sugar beets, and the like. Ammonia liquors come from coal gas which comes from coal. Nitrogen comes from the air, hydrogen from water. In fact, all the ammonia sources can thus be traced back to air, water, coal, and limestone.

This digging back into origins is not just an academic exercise. It may very well aid a producer or owner of some raw material to plan manufacturing and dis-tribution of a product. Since transportation of heavy raw materials is costly, in-telligent knowledge of what is needed ultimately to produce a product may allow shifting of industrial plants to more ad-vantageous locations.

Water and air are the most frequently used ultimate geologic raw materials—used 99 and 96 times, in the case of the 150

chemicals. Next in order are coal. 91; sulfur, 88; mineral salt, 75; limestone, 68; tur, 98; mineral sait, 75; limestone, 68; sulfide ores, 32; brines, 24; petroleum, 23; natural gas, 16; saltpeter, 13; potassium minerals, 11; gypeum, 10. The other 21 raw materials are used less than 10 times each .- Science Service.

GLASS-SANDWICH BRICK

A NEW glass huilding block containing an interior screen of glass fiber that sharply reduces the transmission of solar energy was announced recently by the Pittsburgh Piate Giase Company.

The new hiock, developed by engineers

of the Pittshurgh Corning Corporation.



screen in this giass building block reduces transmitted heat

gives a soft, diffused light that reduces glare of the sun. The decreased solar heat trans-fer cuts down the cooling load in air-conditioned rooms. The characteristics of the new glass block adapt it particularly to large areas where softer natural daylight is desirable.

Both the new and the conventional blocks are made by fusing, at high temperatures, two pressed, square glass cups into an all-glass welded unit. In the newer design a fiberglas sheet is sealed between the ble halves, forming an integral part of the finished unit in the center of the block. As in the older design, the high sealing temperature results in the formation of a par-tial vacuum in the block interior when it cools. This increases the insulating value of the unit.

Variations in the effects desired may be Variations in the effects desired may be had by changing the thickness of the fiber-glas sheet. A typical unit of the newer design transmits only 55 percent as much energy as the older block, but 75 percent as much light with a marked increase la light diffusion.

METHYL BROWDE AS

INSECT "EXTINGUISHER"

METHYL bromide, sometimes used as a fire extinguisher, is proving even more useful as an insect "extinguisher" or fumigant, as it will in many cases kill insects without injuring the plants upon which the insects are feeding. Methyl bromide is used—in control of the Japanese bestlo—in the fumigation of fruits

and vegetables from within quarantined areas. It also has been found particularly useful for treating potted plants and nursery stock which may be infested with the larvae of this insect. After treatment the plants can he shipped outside the quarantined area without danger of spreading the pest.

TANK TRUCK FOR LIOUID CO2

NEW model EFH Mack truck recently A placed in service by the Cardox Corp. oration, of Chicago, is an example of the facilities developed by this concern for transporting liquid carbon dioxide at controlled constant pressures and in hulk quantities.

Since CO₂ liquid has a vapor pressure which is dependent upon the temperature of the liquid, the pressure increases as the temperature rises. Prior to this development, hound COs has always been handled in containers in which the temperature of the liquid would become the same as that of the surrounding atmosphere. Pressures as high as 1500 pounds to 2000 pounds could, therefore, result in the small individual shipping cylinders. Containers for high pressure are necessarily of heavy construction so that large capacity containers were impractical and uneconomical.

Cardox transport equipment, such as that mounted on this Mack truck, consists of pressure vessels with relatively low working pressures as, for example, 300 pounds per square inch. Corresponding temperature at 300 pounds pressure is approximately 0 degrees, Fahrenheit. This container is well insulsted so that heat loss will be low and pressure rise in the tank will be slow. The liquid COs is placed in the tank at a pressure appreciably below the working pressure of the vessel, and a pressure relief valve is provided which will open at the normal working pressure of the tank. With the opening of this valve, CO2 gas is bled off from the top of the tank causing evaporation of liquid within the tank, the evaporation prothus lowering the pressure so that the control valve will again close.

This truck unit can maintain constant pressure of 300 pounds over an indefinite period of time by bleeding off approximately

bleeding valve. However, if the truck tank is filled at pressure of 250 pounds, it will re-quire several days before sufficient heat penetrates the insulation to raise the pressure to 300 pounds. A normal haul is of less duration than the time required for the pressure to reach the point where refrigeration by bleeding begins; hence, in actual practice, no loss of gas is experienced in transit. The unit is equipped with a compressor type of liquid pump which enables liquid CO, to be transferred in either direction between truck tank and storage tank and additionally makes it possible to fill high-pressure shipping cylinders and containers.

FLAME-DESCALING

THE operator in the accompanying illustration is flame-descaling an 18,000ound steel casting for a hydraulic turbine. Flame-descaling is a relatively new process for removing the scale from blooms, billets, slabs, forgings, and ateel eastings by means of specially designed oxy-acetylene heating



Flame-descaling a casting with a special oxy-acetylene heating head

heads. The process is based on the principle that when high-temperature is quickly ap-plied to the scale (or oxide skin) on a piece of cold metal, the scale expands and breaks away from the base metal because of differential expansion between the scale and the steel. Descaling has a number of ad-



Insulated tank track for transporting liquid CO, at constant pressure

as pickling, sandblasting, and chipping. The casting shown here, for example, was flame-descaled in one fifth the time formerly required for chipping.

SELF-CONTAINED UNIT HEADLIGHT

ONE of the most significant developments in automobile headlights has resulted from three years of co-operative research and testing by the entire automobile and headlighting industry in colleboration with public authorities. This is



Headlight lens, bulh, and reflector in one unit for most new cars

the new Sealed Beam headlighting system which has been generally adopted for most of the cars to be announced this fall. The new system promises a great increase in safety for night driving for two reasons: the traffic heam is practically without glare; and, second, the lamps are estimated to give virtually their original illumination throughout the life of the lamp.

The new headlamp is unique in that the source of light, the reflector, the lens, and the gasket are all assembled in a single, securely sealed unit. In other words, the headlamp is a single light bulb itself, the parabolic reflector surface of which is allvered on the inside and cannot therefore be affected by dust or moiature. Two types of sealed beam units are available—one entirely of hard glass and the other a composite unit consisting of a metal reflector and a glass lens. The two types will be interchangeable in the recesses provided for them in the newer cars.

These units are relatively more expensive than the present bulbs but, considering the light efficiency as the new lamp ages, the increased cost over ordinary small bulbs loses its significance. Other advantages are that the filament is always definitely and permanently focused for hest results, a wider and stronger country beam is given, while the traffic heam is thrown more sl arply to the right side of the road and gives better to the right side of the road and gives better illumination even far to the right of the shoulder. When the filament finally burns out the whole unit is thrown away and a new one installed.

FOR FUTURE DA VINCIS

ALWAYS a challenge to designers, world fairs have resulted in the development of a number of new architectural forms many of which have later become generally adopted. It is perhaps in the bold use of = 0.8840 =

WHERE SCIENCE ENDS HOSPITALITY BEGINS



The Waldorf, for example, is a magnificent scientific achievement, not only dependent on science when it was built, but continuously dependent on many sciences for the efficiency of its operation.

But every man of scientific turn of mind knows what we mean when we say that hospitality, in his own home no less than in the Waldorf, is something warm, living and human that survives scientific detachment.

And it is that ability to preserve the human touch, in spite of all our clockwork schedules and efficiency, that gives the Waldorf its unique reputation for mantaining close, cordial and communicable contacts with its patrons.

Besides, this year, when you come to New York, you'll get so much science at THE FAIR, that it'll be a genuine relief each day to return to the hospitality of The Waldorf-Astoria!

THE

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new materials for decorative and artistic effects that the New York World's Fair, howcer, makes its most striking contribution to the progress of art and design. In this sphere, the Fair has given an impetus to the technological developments of the last few years which may hasten by years their general adoption.

Outstanding is the decorative use of plastics, most notably the brillandity refractive transparent varieties now available. Domenico Mortelluto, for example, has achieved in his mural in the lobby of the De Pont Building, a design remniscent of stamed glass but with a refreshing balance of colors and textures attained by use of the soft and plastic properties of these new materials. The nun-foot cast-phenoine status in the Federal Building, designed by E. H. Burdeck, lighted from within, provide a considerable part of the illumination of the tall plants, whose natural illumination of the tall plants, whose natural illumination strikingly accents different portions of the rounds, are faced with blastic materials.

The use of stainless steel as a scalptural material has been notably advanced at the Fair, as Dr. Gerald Wendt, Director of its Department of Science and Education, has pointed out. Robert Foster, a pioneer in the use of the welded steel sheet, has two gagantic figures in this medium. His winged Mercury," floating in brilliant stantless steel from the wrands roof of the Ford Building, brings out to full advantage the lift, the apparent floating hightness of the speedy mesenger of the good, it his brotic fold of cloth draped over her extended arms. The later mural in the French Paullion

The large mural in the French Pavision by Jacques Durand is done on wood, with synthetic lacquers containing colloidal gold in the focal exhibit in sectione, Allen Saal lurg has used a new technique, painting large transparent murals on gless, using alcohol-soluble dyes applied by the sir brush. Witold Gordon's mural, "Food," is done in rubbe-base paint.

The nex tube lights, lined with fluorescent materials, have rivinled the color of the Fair and are largely responsible for its moctural beauty. Especially striking is the device which sends a vertical beam of light form mercury lamps, set in the sod, upward into the trees. Each quivering leaf glowwith a soft green light resulting from the fluorescence of its chlorophyll. To many, the Fair's heautiful illumnation is its out establing new art form and most memorable with the standing new art form and most memorable D. Luttle. Inc.

DETERMINATION OF

COBALT IN STEELS

In the standard method of analysis of steels and sloys, set to sight hours are required by an experienced chemist for a determination of cobait. By further developments of an electrochemical intration ments of an electrochemical intration company to the second of the second company have made presented as the second company have been second co

In the new method, a sample is dissolved in acid, the cobalt oxidized with a definite excess quantity of standard potessium forricyanide, and the excess determined by titration with standard cobaltous nitrate solution. The amount of cobalt in the sample as calculated from the amount of ferricyanide used for its oxidation.

CAMERA BECOMES A POLICE WITNESS

OFFICER Rollye H. Galbrath of the California Highway Patrol has a positive method of recording the actions of law violators who cross his path in the vicinity of Laneaster, California On the dashboard of his patrol car Officer Galbrath has installed a "robot witness" in the form of a



The camera that pictures speeders Filmo 70 camera that records the action of

the car being "tailed." A photronic cell exposure meter is mounted in a bracket beside the camera.

"You can't argue with a motion picture," is a statement football coaches have been making for years, and in bringing "witness" movies to the police court, Officer Galbraith is pioneering in a field that promises great results.

For definitely proving a case against speeders, why not fasten a second speedometer in front of the camera, so that its dial would appear in a lower corner of the field, with the speeding car visible in the same picture?

IMPROVED SURGICAL SUTURES MADE OF NYLON

N YLON mono-filament is now being used to make surgical sutures. Nylon, the same Dir Pont material that will enter mio fine hosiery, is a man-made, protesn-like usubatance derrord basically from coal, air, and water, characterised by extreme toughous and strength, and possessing the peaking to be formed into filters and allily to be formed into filters and allily to be formed into filters and national coals.

The new sutures have been tested by more than twenty important hospitals and medical conters throughout the country, and declared a marked improvement for dermal sutures. It is said that they are practically non-dritating to the tissues, do not deteriorate is the presence of infection, and

How Mickey Mouse joined our family

by Westinghouse



- "Plastic dishes with pictures of Mickey Mouse—how in the world did Westinghouse get into that line?" asked a buyer. Well, it's an odd story, showing how the logic of production sometimes leads to surprising answers.
- Among the many electrical products that we make are the outlets, switches, plugs, fuses and other
 little connections needed in a wiring system. They are known as
 Bryant and Hemco wiring devices,
 and are made in our factory in
 Bridgeport. In 1928, when the
 amazing possibilities of plastics were
 startling industry, we took over a
 nearby plastics plant to mould these
 various devices.
- The capacity of this plant was greater than our needs, so we either had to cut it down or find new uses for plastics. About that time, scientists created new plastics in vivid, rainbow colors—marvel-ously suited to tableware, toys, smokers' fittings and hundreds of such things. It seemed a long jump from dynamos and motors, but we had the plant and the plastics, so we plunged into the new field.
- Famous designers went to work — skilled tool makers made

hundreds of new dies — we hired salesmen who knew dishes and tumblers rather than switches and plugs —and almost before we knew it, had an important new business on our hands.

- · Our first big hit was with children. They were delighted with fascinating dishes decorated with pictures of Mickey Mouse, Snow White, and other lovable people who live in story books. We have sold millions of dishes glorifying Mickey and his gang! And millions of gaily colored spoons, plates, tumblers and kitchenware, all identified by the well known names they bear -Hemcoware or Safetyware. That ashtray on your desk, the plastic housing of your new electric razor or the beautiful plastic cabinet of your bedside radio-they probably are all of our make.
- Today, this plastics plant is busy with orders from chain and department stores from all over the country...from sales organizations who use these products for premiums and novelties...and from manufacturers who are using plastic parts in their products.
- To us Westinghouse people, trained as we are to do years of research before launching a new electrical product, this overnight success that seems almost to have come out of the air, is startling and effenshing. Actually, of course, it did take a lot of planning and good team work—but still, it's fun to look back and see how Mickey Mouse came to join the Westinghouse family.

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because the filament is non-capillary, the possibility of infection penetrating the suture and being carried into the wound is diminished.

Because of the smooth surface of nylon, there is less discomfort in removing the suture from the tissue. The sutures are fast dyed—an aid to the doctor in locating the surgical stitch readily.

LARGE TIRES TO END ALL

LARGE TIRE STORIES

VIGANTIC pneumatic tires that stand J seven feet high-and considered the largest made for actual use are now being manufactured by United States Rubber Company, L. D Tompkins, vice president, announced recently.

The tires are of the size known as 24.00-32, and weigh approximately 1500 pounds each. They are of 34-ply construction, and the rub-



A giant among tires, compared with an ordinary passenger car tire

ber tread at places is more than three inches thick. They comprise the tire equipment on large LaTourneau Tournapull earth-moving machines used by the Guy F. Atkinson Company, of Los Angeles, in building the Hansen Dam near San Fernando, California. These machines are capable of carrying 30 cubic yards of earth at a speed of 17 miles per hour.

Each tire, when inflated-the tube itself weighs 100 pounds—has a load capacity of about 12½ tons. Three men, using a special-ly designed derrick, require five hours to

change one of these tires. Shipping of the tires necessitated the use of open-end railroad cars, as the doors on the ordinary freight and express cars were not large enough to get the tires through.

LUNG COLLAPSE TO

CONTROL TUBERCULOSIS

OLLAPSE of the lung for persons suffering from tuberculosis has been found by the Chicago Municipal Tubercu-losis Sanitarium to be twice as effective a treatment as other measures directed against the control of the disease. A critical study of 7341 cases is reported by Drs. Fred-erick Tice and Allan J. Hruby of the Chicago institution in the Journal of the American Medical Association.

Of title 7341 patients observed, over a

6 1/2-year period, 3090 were subjected to lung collapse for more than three months, 337 for less than three months, and 330 had pneumothorax attempted. The other 3584 patients were controls.

Broadly, the results were twice as good with the treated patients as with the conirols and were better still in comparison with the life expectancy of patients with open tuberculosis as revealed in the medical literature,-Science Service.

SIGHT AND SOUND TOROUG INDICATING WRENCH

NEW type of torque measuring wrench which can be applied to any detachable socket having a 1/2-inch square drive opening, is now on the market. This wrench is of the reversible ratchet type and is designed

to indicate right-hand torque. With a wrench of this type, it is possible for the operator to tighten nuts or bolts even-



Uniform tension on series of bolts is possible with this new wrench

ly and to any desired tension or torque load. Closely limited torque application is now considered essential to many types of automotive, aviation, Diesel-engine and indusirial work.

In application, the wrench may be used by utilizing either the calibrated scale which, by sight-reading, shows applied pressures of 20 to 200 foot-pounds, or by a sharp soundsignal which is given for any desired torque from 35 to 200 foot-pounds. The calibrated scale is read at a point where the index shoulder crosses the scale and the sound signal can be set by a simple device.

Accuracy of the wrench does not depend on gears, levers or dials. Although right-hand torque only is measured, the wrench action reverses for left-hand turning. The 36-tooth ratchet wheel, with twin double-tooth pawl of the reversible ratchet mechanism, makes possible the short operating swing of only 1/36 of a full turn. Wrench action is instantly reversed by a flip of the shifter, located flush with the head.

HIGH EFFICIENCY RAUROAD BRAKE

NEW type of railroad brake which will A bring high speed trains to a smooth, comfortable stop within 2500 to 3000 feet from 100 miles an hour—about half the from 100 miles an hour—about half the distance now required—was announced recently by Edward G. Budd, president of Budd Wheel Company.

The brake eliminates the century-old principle of a metal "shoe" pressing against the rim or tread of the wheel. Instead, the

engineers have patterned the new brake somewhat on those used in automobiles in

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that a composition shoe is used. This shoe exerts pressure upon an air-cooled disk or drum, mounted on the axle inside the wheel to bring the train to a rapid, but smooth stop. Special control devices automatically prevent the wheels from sliding when the brakes are applied suddenly.

The new brake solves many of the problems of high speed train operation. The first is the effective control of a train travel-ing at high speed. "Flat wheels," highboo of railroad men, are climinated. Wheels and braking mechanism no longer will get

red hot on long grades.

The new brake was developed in the research laboratories of the Budd Wheel Company under the direction of C. L.

Eksergian, chief engineer, who has devoted many years of research to the development of wheels and braking systems, in automotive and other fields

The first complete train equipped with Zephyr, of the Burlington I mes

PASSENGERS

N a year, the American railroads carry approximately 500 million engers or equal to the combined population of North and South America, the United Kingdom, France, Italy, Poland, Spain, and Germany. More than a billion tons of freight are also handled each year by these carriers.

CIGARETTES ARE PIPE

FILTERS THOSE people who started that cut-down on-your-smoking craze, and showed

more than a million cigaretic smokers how to do it by using two cigarcites at a time instead of one, are back at it again This time it's a pipe!

They did the eigneste track with an aluminum holder in which you smoked one eigarette through another, the second eiga rette acting as a filter. (& rithed tests showed that this removed about 70 percent of nicotine, tars, and other undesirable ingre dients of eighteties

Now they have succeeded in applying this principle to pipes. With the Zeus eigarette filter pipe you can smoke a "hodful" of



Above: Two half eigarettes, in the broadened stem of the pipe shown below, act as efficient filters



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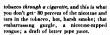
equipment that is not only pleasing to the eye, but highly practical. There are no sharp corners in which dirt or chips might

rolled rim which serves as a chip pan or oil pan. The sides and back of the bench are enclosed in smooth panels securely welded to the frame work. The front is open to permit the operator to take a comfortable working position either sitting or standing. The entire bench is finished in standard

The lathe motor drive equipment is lo-cated in the left side of the bench, while in the right side are three large drawers for storage of chucks, tools, and accessories, Each drawer has an individual tumbler lock combined with a latch and knob.

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PROPULSION



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curiosity. Not even the inventor could foresee any practical implications to the achievement. He contented himself with writing a letter to the American Philosophical Society in Philadelphia about it. Looking backward it is different. This

Looking backward it is different. This was probably the first time in history that propulson had been achieved and distance occured by means of an internal combustion engine, and the little boat may have been the dim morange star of the motor age. The engine is described by Frank A. Taylor, Caratro of Engineering of the Smithonian Institution, in a descriptive catalog of the Museeum.

Morey's model unfortunately is no longer in essiones. The inventor did not even try to get an American patent on it. All that remains a his description of the device, summarized by Mr. Taylor as a vapor engune in which "a vacuum was produced in the cylinder by firing an explo-ave mixture of air and vapor from common proof-sparits mixed with a small portion of sparits of turn of the properties." A model of this engine ran smoothly for several buns, but there is no record that a large engine was every built.

SUNLIGHT AND

AGRICULTURE

CCIENTISTS in the laboratories of the Jitavaina Sugar Planets' Association in Honolulu are now working on a project which promises to bring the annight factor within the realm of predictability for farming. Their experiments interface that sunlight and its effects upon agriculture can be measured with a faur degree of accuracy. The implications of such a discovery for sarriculture are far-reachings.

The inquiry grew out of experiments which the Experiment Station has long been conducting in the water-absorption rate of growing cane. These experiments revealed that there is a direct and calculable relationship between the intensity of solar radiation and the "thirst" of the rane.

Indeed, so sensitive is the plant to the sun that a mere whey of cloud, passing across the face of the sun, will definitely affect the water consumption of the cane After sundown, as every farmer knows, the water absorption rate of a plant will quickly diminiah. But it is not so generally knows that there are similar changes in the rate of "drinking" during the daylight bours. These changes, it was learned, bear a distinct relationship to the variation in the contract of th

Under the direction of Dr. Harold L. Lyon, head of the Hawaiian Sugar Planters' Association Experiment Station, physicist Hugh W. Brodie has been working on this problem since 1930.

An outgrowth of these experiments has been a parallel study of the possibilities of a large-scale control of trrigation based on sunlight data. This work is now in progress at the Hawaiian Sugar Planters' Association Experiment Station.

The value of such an inquiry may be realized from the fact that, for every pound of sugar produced in Hawaii, a ton of water must be used. Several of Hawaii's larger



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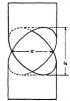
ANOTHER

MATHEMATICAL

PROBLEM

BECAUSE of the interest shown in previous problems, we offer another by Leutenant-Commander Kaplan. Any correspondence relative to this new brain-teaser should be addressed to him in care of Scientific American, 24 West 40th St., New York, N. Y.

The problem: A hole 2 inches in diameter is drilled through a solid cylinder also 2



inclies in diameter, in such a way that the axis of the drill is perpendicular to, and intersects, the axis of the cylinder. What

is the volume of inaterial removed?

The solution will be given in these columns next month. Meanwhile, can you obtain the same answer as the author? His value was 53 cubic inches

better than commercially available enameled wire. It can be used to advantage in nearly all applications where enameled wire has been used, and in addition it can be utilized in many applications to replace enamelcution, enamel-paper, or other fabric-covered wires where formerly a protective wrapping was necessary.

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Sixty-five pounds of the material are required per cubic foot of finished construction. It can be used to form any required refractory shape. This is accomplished within a short period of time simply by mixing light weight Firecrete with water and casting it into a form. Twenty-four hours later the shape is ready to be placed in

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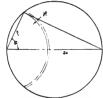
Ultrakote Synthetic can be used on any production metal, ranging from the manu-facture of delicate jewelry to heavy ma-chinery, including the following: metal kitchen cabinets, stoves, refrigerators, ironers, washing machinea, clocks, office machines, and many other applications. can be applied by spraying, dipping, or roller coating. It bakes to a tough, flexible finish at 150 degrees, Fahrenheit, in 30 minutes.

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SOLUTION OF LAST MONTH'S PROBLEM

AST month, in response to many requests, we published another problem for our mathematically minded readers. Briefly, it was required to find the length of a rope with one end tied to a cow and the other to the edge of a circular pasture 200 feet in diameter. The rope allowed the cow to graze over half of the total area of the pasture.

The solution of this problem, as outlined below, requires the use of the calculus. Reference to the illustration will clarify the symbols used by the author.



The area encompassed by the radius arm o is given by the integral

This may be changed over into an expression involving only the one variable, 6, Since

$$\rho = 2a \cos \theta$$

stitution.

and
$$d\rho = -2a \sin \theta \ d\theta$$
We have, therefore, by making this sub-

 $\int_{2} (2a \cos \theta) \, \theta \, (-2a \sin \theta) \, d\theta =$ -4a' f sin 20 d0

If, for simplification, we let v = 20

dy = 2 d0and the expression for the area becomes

$$-a^2 \int y \sin y \, dy$$

Integrating between the limits

 $\theta = \frac{\pi}{2}$ and $\theta = \theta_0$,

which for y will be $y = \pi$ and $y = y_{ij}$

$$a^{3} \left[y \cos y - \sin y \right]_{\pi}^{y_{1}} =$$

$$a^{3} \left[y_{1} \cos y_{1} - \sin y_{1} + \pi \right]$$

Since, by the condition of the proble this area is to equal one half that of the circle

$$a^{1} \left[y_{1} \cos y_{1} - \sin y_{1} + \pi \right] = \frac{\pi a^{1}}{2}$$

$$\sin y_1 - y_1 \cos y_1 = \frac{\pi}{2}$$

The value of y, which satisfies this equation may be determined by constructing a table such as that shown below, and successively reducing the error of approximation to whatever degree desired.

From this table, it is evident that

 $\gamma_1 = 109^{\circ}11'18''.9$ (very nearly)

$$\theta_i = \frac{y_i}{2} = 54^\circ 35' 39''.5$$
the corresponding value of ρ , using

and the corresponding value of ρ , using 200 feet in place of 2a, will be $\rho_1 = 200$ cos 54°35'39".5 = 115.87 feet

yı (degrees) 110°	yı (radians) 1.91986	cos y ₁ .34202	y ₁ cos y ₁ 65663	sin y. .93969	sin y ₁ — y ₁ cos y ₂ 1.59632
109*11'.3			91 143 × 60 =		1.57080
109*	1.90241	.32557	.61937	.94552	1.56489
109*20'	1.90823	.33106	.63174	.94361	1.57535
109*11'.3	(By int	erpolation, 6	$\frac{8}{23} \times 10 = 1$	'.30)	1.57080
109*10'	1.90532	.32832	.62555	.94457	1.57012
109°12′	1.90590	.32887	.62679	.94438	1.57117
109*11'18".9	(By in	erpolation,	$\frac{17}{54} \times 60 = 1$	8".9)	1.57080
109°11'	- 1.90561	.32859	.62616	.94447	1.57063



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WHAT POSE?

ONE of the worst bugaboos the nonprofessional photographer has to encounter in his camera work is the selection of a pose suitable to the subject, and one that gets away from the usual thing. Cen-



Figure 1

rally speaking, the head may be posed in one of three principal positions with relation to the camera—full face, these quarter view, and profile. But such a rule as much too wagne, almost too obvious, to be of real use when the purpose is to obtain a portrast that is alive with personality and not merely al likeness, ow that is presumed to he's likeness. Moreover, a true likeness is not merely a physical resemblance, but a character im-

pression.

Posing may broadly be classified in two divisions—the formal and the informal. The formal post formal post is ordinarily associated with the studio or the carefully tranged sensitied with the studio or the carefully tranged sensitied with the studio or the carefully tranged sensitied with the sensitied professional? Portrait type, and which the subject is portrayed in conventional style. Both subject and photographer are conscious of engaging in a rotutine, a sober, methodical routine the end creatify which is the familiar "studio portrait." Not that this type of portrait the pressonality is reteriand; if rited of the subject who see the picture do not quite the personality is reteriand; if rited of the subject who see the picture do not quite recognize the person they know in life.

By contrast, examine Figure 2 and see the difference. This is the subject as we know her, smiling easily and gracefully; vibrant, sparkling, alive. Taken in the studio, also, the method employed was radically different from that used for Figure 1. The subject lighted a cagarette and was allowed to act naturally, to converse and generally to be 'ber sell.' When things booked ripe, ment was caught forever. Figure 2 is as much of a portrait as Figure 1, but which would you vote for 1f you had to make a choice between the two for a prominent piace on your bureas?

Figure 2 is an example of the modern treatment in portrasture, and so are the others reproduced here. Figure 3 is an outdoor shot in the informal manner. A miniature reflex camera was directed from overhead to record a characteristic por and expression, entirely unrestrained and completely at ease. It is easier outdoors to make shots of the informal type with success, partly because of the diffuse and ail-embracing nature of daylight, which permits exposures without having to be too much concerned with light arrangements, partly because subjects seem to be less camera-conscious outdoors. This is one reason why one frequently hears the comment that "the best picture ever taken of me was a snapshot at such-and-such a picnic" . . or boat ride or hike.

or feat rice or mase.

Figure 1 is a many any contrait by Figure 1 is a mean subject, seated on a bench, learned back, restung on her hands and turning her head toward the camera In the final printing it was found that the best result could be achieved by electing the head alone and enlarging that to the final dimensions of the print, and Figure 5 shows how this was accomplished to the great enhancement of the result. Incidentification of the print of the first proved by the simple expedient of deleting the non-seasufish and concentrating on the



Figure



Figure 3

face alone. The angle of the head adds considerably to an impression of liveliness, gayety, movement.

Rules, they say, are made to be broken hut here is one that you will do well to follow: never have the portrait subject facing the camera with both shoulders on a line with the lens. Have one shoulder nearer the camera than the other. When



Figure 4

the subject then turns her head toward the camera, the result will be much more agree-able. Thus, Figures 1 and 4 were posed with one shoulder toward the camera, and Figure 2 with the shoulders at a slight

angle.

The lighting arrangement for Figures 1 The lighting arrangement for Figures 1 and 6 consisted of a main, diffused light, combined with a soft spollight; Figure 2, a spoilight and a soft main light from below, and Figure 3, daylight, with the sun crusiable point peneral oft illumination and a spollight effect. But why is the subject always smilling, one singlet sak? The nanewer to that one it the subject is most characteristically presented in this way. She is at her best



Figure 5

and most revealing when she smiles. Another subject might be untruthfully photographed while smiling, but whether the subject should smile or not is entirely an individual question. One cannot make gen-eralizations; study the subject and record the most favorable and attractive pose and

WHY A FILE?

YOU do not have to have a regular photographic filing device of any kind. I tographic filing device of any kind you may ators your negative in ordinary envelopes and keep them in the bursau. You may ators your negative in cordinary envelopes and keep them in the bursau. This kind of makeshift arrangement may be good enough for 'your purposes. But for those industrious workers who accommisted large numbers of negatives, particularly ghere the negatives vary in size, a somewhat more elaborate system will be found not only convenient but essential. Especially will this be true for the man who intends now and then to dabble in journalistic photography where the shilly to find negatives quickly when needed is





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Remember that these prizes are to be given in each division—or a total of six watches and six enlargers totaling \$137.38 in value, including the 18 subscriptions to Scientific American

*Watch wingers may make their ewa esjection of neoket style or sentiamen's ar lady's wrist watch.

The contest will be judged in three divisions, as follows: Division .i. Human — including portraits and other camera studies of people

vicion 2. Landscapes—including i scanic views, closs-ups of parts landscapes, nesscapes, and so

Division 8. Action—including all types of photography in which ac-tion is the predominating feature.

First Prizs One \$250 "Lifetims" LONGINES WATCH

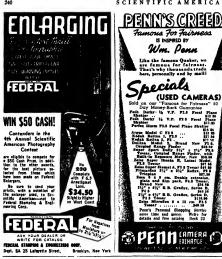
Third Prize

Ons FEDERAL #836 VARIABLE PROJEC-TION PRINTER (List Price \$29.50)

Second Priza

One \$125 LONGINES WATCH

Fourth Brite Oss FEDERAL #120 ENLARGER (List Price \$17.95)



of the utmost importance. The lack of a good system may frequently mean the dif-ference between a sale and a missed opportunity to cash in on one's hobby.

FLOWER CLOSE-UP

FOR rendering details in flowers, the I close-up supplementary lens is fre-quently employed to advantage. The picture of hollyhocks reproduced here, for example, was made with a miniature reflex equipped



"Hollyhocks"

with a proxar supplementary lens which permitted an approach to the subject much closer than that possible with the unaided lens. Incidentally, the picture shows the flower in several stages of development, from the closed bud onward. In the present instance, some foreshortening may be seen in the near petals of the largest blossom, although it does not appear to be objectionable

FIFTH ROCHESTER

INTERNATIONAL SALON

ENTRIES are now being invited for participation in the Fifth Rochester International Salon, to be held at the Rochester Memorial Art Gallery, Rochester, New York, from January 15 to Febru-ary 25, 1940. The closing date for the submission of entries is December 14. Entries are divided into commercial and pictries are divided into commercial and pic-torial groups. Fee is \$1 which includes the right to submit to the maximum of 6 colored lantern alides, 4 monotone prints, 4 color commercial prints, and 4 color pictorial prints.

VIEW CAMERAS

IN DEMAND

RECENTLY we have been noticing a considerable revival of interest among amateurs in the use of the view type camera-Particularly does this seem to be true of the 4 by 5-inch view, such as the Kerons and the newly introduced Crown. Secondhand view cameras of this type that appear hand view cameras of this type that appear in the stores do not seem to stay very long and one frequently hears favorable com-ments concerning the use of a type of cam-era that has usually been associated only with professional studio workers. While the

OVER

in PRIZES

Fourth Annual SCIENTIFIC AMERICAN AMATEUR

PHOTOGRAPHY CONTEST

EVERYONE who owns a camera has L'VERYONE who owns a camera has La chance of winning a valuable prise. Make plans now to enter your prints in the contest. You may enter any or all of the three divisions, but not more than two prints may be entered by one con-testant in any one of the divisions.

Specific rules for this contest were pub-lished in our September number. Be sure to read them before you submit

In each division there will be prises of two Longines watches—"The World's Most Honored Watch"—and two Federal Sniargers, as well as five Honorable Mention Awards. This Contest Closes December 1, 1939, at Which Time All Entries Must be in the Hands of

Photograph Contest Editor, Scientific American

24 West 40th Street

New York, New York

view camera, even the 4 by 5, is limited because it has to be used on a stand, many find it ideals for indoor portrature and other subjects; even landscapes. The 4 by 5 size, the "minasture" of the 8 by 10 and 11 by 14, is easily carried in a small fiber case, together with the necessary film holders and so on.

PHOTOGRAPHING THE

A WALK in the park for the express purpose of making a photograph of Sandy offered an unforeseen problem. Sandy was obedient enough and would stay in one place for minutes at a time, but he seemed



to be fraghtened at the sight of the camera and would not behave normally Sometime-be cowered; at other times he was higher and nervous. One of the difficulties was getting his ears to stay up. This was finally secomplished, after many attempts, he vomore standing just behind the photographer and, by one sign and another, convincing some standing behavior of the state of the stat

THE CAMERA SISSY PHILOSOPHY

PERSONALLY, we like to buy a cannorin a brand new condition, never handled before outside the photographic store. We have been the feet of the property of the tear according to a manner has come as a result of having been handled and used by us in the course of our picture-making activities. As time goes on and the camera assumes a worn condition it is comfortable to know that it became so because we had used it frequently. The camera, by these sentant of wear becomes associated with our personal experiences and the pictures we made with it.

We smit that, like other camera mers, we desire occasionally—and, when we can afford it, fulfill the desire—to trade in our camera for a now one, one equipped with the newer gadgets. They are hard to resist, these handsomely contrived, new camera models, not only because they are good took at but the few gadgets are real improvements and signify advances in camera'd design. Nevertheless, no matter how

COMPETERS TO MOTHER

Here are examples of how you can buy the camere you went od our Nettonal Time Peyment Plan Every	NEW CAMERA	List Price		Monthly Payments
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Send for free descriptive	Minature Sperd Graphic 2½x3½-K A f 4 5		12 00	12.00
folder end order blenk for	• Argus C-2	25 00		4.00
camere you want Or bet-	Rolleicord II	77 50	8 00	9 00
ter sull, send 25c for our	• Holleicord I-A	57 50	6 00	6 00
complete Hendbook & Cata-	Automatic Rolleiffex freem	152 50	17 50	16 00
log. (Relunded on your	• Recomar 33	63 00	7 00	7 00
first purchese) Size 8 1/2 x 11", 85 pages, 175 illus-	Contax II-Zeiss Tessar f 8 5 Jens	234 00	25 00	25 00
tretions Contains value-	Super Ikonta B	160 00	17 50	17 00
ble stticles, descriptions and	· Super Sport Dolly-Meyer Triopian f 2 9 lens	37.50	4 90	4 00
prices of leading cameras	Voigtlander Buby Bessa-Voigtar f 3 5 lens	45 00	5 00	5 00
end eccessories	Korelle Reflex I-Cassar f 3 5 Jens	70.00	7 00	8 00
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	Kodascope Eight Mudel 50		4 00	4 00

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Volgtlander Brilliant-Anastigmat Volgter 4		4 00	4 00
Leica 111-b-Summar 50mm f 2 lens	195 00	20 00	21 00
Recomar 33	44 50	5 00	5 00
Certo Dollina II Radionar f 2 9 lens	40 00	4 00	5 00
Korelle Reflex 1-Victor f 3 5 lens .	49 50	5 00	5 00
('Inr Kodak Eight 20	17 50	4.00	4 00
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There are persons, however, who look upon this camera sissy philosophy with disdain. They prefer an old camera, a used camera, and they don't care how many people had used it before they took posses sion. A camera is a camera, they say, and what's the difference so long as it works? Well, that's one way of looking at it, and maybe we're wrong. But we know that many people agree with us and would rather save up the few extra dollars required to make the sum asked for by the dealer than to buy an old camera now, because they do not have the few extra dollars, for the mere sake of ammediate acquisition.

BOOK PLATE

SUCCESTION

ME backlighting of the leaves and the simplicity of the arrangement were the things that attracted us to the subject of the hanging rambler branches. A red filter was used for the sky and the moment was awaited when the cloud mass moved along



Design for a bookplate

into the desired position behind the subject. Because of the near view, the clouds were naturally rendered very soft-edged so that the purist might object to the picture on this account, declaring that the clouds have too much the appearance of a piece of cot-ton pasted in the aky. However, clouds do not always have to be rendered sharp. One does feel, however, that the picture is somedoes feel, however, that the picture is some-how incomplete. A solution that immedi-ately comes to mind is the use of the print for a bookplate, with the usual wording lettered in the roomy space in the lower left part of the print.

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IN carrying filters and supplementary I lenses of the proxar and distar types, provide yourself with individual cases of hard leather or Bakelite, if these are not furnished with the filters and aupplementary lenses when purchased. Carrying these items in the vest pocket or carelessly in the pocket without any protection whatever is bound to result in dust-covered elements that are also likely under these conditi

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SCIENTIFIC AMERICAN 24 West 40th St., New York, N. Y. to be scratched or broken. You should be as careful of these as you are of the camera lens itself, for it must never be overlooked that the filter or supplementary lens is placed over the taking lens and that any damage suffered by these elements will have its effect on the negative.

WHAT'S NEW

In Photographic Equipment

If you are interested in any of the items described below, and cannot find them in our advertising columns or al your photo-grophic desire, we shall be glad to tell you where you can get them. Please accompany your request by a stamped emotopy.

Zeiss 6 by 6cm Ikoplex III (\$199): 21/4 by 214-inch swin-lens reflex camera equipped with Carl Zeiss Tessar //2.8, 8cm



(31/6 inches) Spring pressure plate assures film placement in focal plane of lens. Tessar matched with //2.8 finder lens of same focal length, projecting image of subject on plano-convex focusing screen. Illumination uniform over entire

screen area. Four-times magnifier covers enscreen area. Four-times magnified covers en-tire focusing screen. Quarter-turn wheel focuses four feet to infinity. Scale on focusing wheel shows depth of field. Albada eye-level finder in which front element tilts forward and back as lens is racked out and in, correcting for parellax at all distances. Operating lever, with one smooth movement, simultaneously winds both film and shutter. Counter dial shows number of exposures made. Half-turn of lever advances film, spacing negatives evenly and winding shutter with one motion. Shutter is Compur-Rapid with speeds from 1 second to 1/400, bulb and self-timer. Signal shows whether shutter is discharged (black), wound (red), or set on self-timer (white). Sbutter release adjacent to operating lever. Shutter speed and lens aperture settings controlled by levers on each side of shutter and visible in separate win-dows on top of camera. Double exposures and skipped frames eliminated by coupling of film-transport and shutter-winding mechanism. Tripod socket accepts standard American screw. Eyes for carrying strap. Standard 37mm slip-on filters and lens shade, as well as new Zeiss Ikon 35.5mm screw-in filters, fit lens. Film is loaded in usual way, then advanced until arrow (on paper leader of all film) lies between white dots on inside of camera. Hinged back is then closed and automatic counter mechanism goes into action

BEE BEE ATLAS TRIPOD (\$7.50): For all types of cameras, including 5 by 7 view and cine cameras. Three sections, all chrome with satin finish. Has reversible chrome with satin finish. Has reversible feet, peg on one aide and rubber tipped on other. Weight three pounds. When closed, legs 23 inches long; open, extend to 60 inches. Tripod guaranteed against mechanical imperfections. Packed in weather-proofed tubular container which may be used as carrying case.

Univex Micrographic Enlarger (\$27.50): Incorporates automatic film pressure re-ase, which permits sliding negatives with-

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JACOB DESCHIN, conductor of our "Camera Angles" department, will answer in these columns questions of general interest to amateur p hotographers. If an answer is desired by mail, enclose a stamped, address envelope. Queries should be specific, but Mr. Deschin cannot undertake to draw comparisons between manufactured products nor to advise on the purchase of equipment or materials.-The Editor.

Q. I would like to get a picture of the moon, using a 3-inch refractor made by Bausch & Lomb prior to 1900. The objective is clear and I would use a 1-inch eyepiece. It is my underatanding that if I should use a camera, it would be used simply as a film holder and the lens would be removed from the camera. I would like your advice as to the mechanical arrangement of the equipment; also as to the type of film to use .- J. C. C.

A. The procedure sometimes employed is to remove the eyepiece of your telescope and attach in its place the lightest ground-glass camera you can find. The camera lens is removed and focusing and exposure is done as normally. Very fast film, such as Super XX or Superpan Press is required and an exposure not exceeding one half second.

The correct focus must be found by trial and error because astronomical telescopes are corrected for the visual, not the chemical (photographic) rays. This experimentation is done as follows: Focus with the eyes as usual, getting the image as sharp as post Now, moving 1/16 of an inch at a time, rack Now, moving 1 to or an incident at a time, the the film plane forward, making an exposure each time you have moved the film plane to a new position. Develop the negatives and study the resulting pictures, from which you can select the one that appears to have heen focused the most sharply Mark the point of correct focus in some permanent way so that all you will have to do in future is to set the film plane at this point without further focusing. Incidentally, the negatives will provide a test of the required exposure. If the negatives are too dense, this will mean that a shorter exposure than one half second

that a shorter exposure uses use and a may be given.

Another method, using a reflecting telescope, is described by Harold A. Lower in his article on "Celestial Photography" in "Annateur Telescope Making." The image of the moon as the focus of a six-inch misror," writes Mr. Lower, "will be about half the control of the moon as the focus of a six-inch misror," writes Mr. Lower, "will be about half the control of the moon and the control of the control o an inch in diameter, but it is so bright that it may be magnified by an eyeplece to about an inch, and still be bright enough to an men, and sum pe origin emough to photograph with an exposure of less than a second. Use an eyepiece of about one-inch focus, and project the image of the moor on a sheet of ground glass. Determine the distance from the eyepiece which is

required to produce an image one inch in diameter. Then make a box to mount over the eyepiece, which will hold a plate-holder or ground glass focusing screen at the proper distance. There should be a door in the side of the box, so that one can adjust the eyepiece until the image of the moon is sharply focused. A small reading glass is quite a help in determining when giase is quite a neip in determining when the image is the sharpest. When the focus is the best obtainable, replace the ground glass with a plate-holder. Have an assistant glass with a piate-noicer. Fixee an assistant hold a sheet of black cardboard in front of, but not touching, the telescope. Then re-move the slide of the plate-holder, look through the finder and make sure that the telescope is centered on the moon. exposure is made by moving the cardboard exposure is made by moving the cardboard edgewise from in front of the telescope, snd replacing it as quickly as possible. Be care-ful not to jar the telescope. If the exposure is short enough, the motion of the moon will not be rapid enough to cause a blur, even if the telescope is not equipped with a clock For further details we suggest you consult the article, which appears on pege 254 of the 4th edition of "Amateur Telescope Making."

Q. I have a camera with f/4.5 lens. Unfortunately, there is a nick on the rear element. Due to the fact that no branches of the German manufacturer are in New York, I am unable to have the lens polished. Do you know of an optical concern which will polish it? Also, if worse comes to worst, under what conditions would the nick be the least discernible on the negative? That is, should I attempt to fill it with Canada Balsam, or blacken it to avoid reflection?-T. F.

A. Although there is no manufacturer's "branch" in this country, the importer of your camera can undoubtedly help you.

Concerning your last question, Arthur Lockett, author of "Camera Lenses," s standard work on the subject, advises that "a cracked glass may not impair the per-formance of the lens unless the outline of the crack is, so to apeak, markedly priematic or irideacent in effect." Even then, he suggests that the lens may be made to work astisfactorily by painting a narrow line of opaque black varsish around the crack or

- nick. "This most probably will not above at all on the screen," he adds," and will only subtrast infinitesimally from the amount of light. Similarly, a broken lene say be comented, preferably with Canada Balasan; but if this is difficult, the "Diamond' coment used for mending china, etc., will answer, or even a strong, hot gelatine solution." We would suggest you make asveral exposures with your lens as it stands and carefully examine the resulting negatives; if you can detect no real fault continue to use the lens as it is. Otherwise, ask the camere importer to recommend a good lens repair firm.
- Q. Occasionally I have to turn out a large number of prints and profer to keep them all in the wash water until I get through with the ontire batch. This may take several hours and the first prints will therefore have to stay in the water all that time. Will excessive washing hurt the prints?—L.K.M.
- A. Excessive washing sometimes causes frilling. An effective preventive that has been used with large prints, such as photomurals, that have had to be left in wash water overnight, is to add to the wash water about 5 percent of sodium bisulfits.
- Q. Please advise what model or number motion picture camera made by Eastman would be most suitable for a beginner—also projecting equipment.—T. S. C.
- A Queries concerning the equipment of a particular firm should be addressed directly to that firm as they are in the best position to give advice concerning cameras and equipment of their own manufacture. Accordingly, we have forwarded your inquiry to the Service Department of the Eastman Kodak Company.
- Q. I have heard it said that when photographing at high altitudes, it is necessary, because of the increased brightness of the light, to decrease the normal exposure. How much shorter should the exposures be?—S. E. L.
- A. That depends on the altitude. For a general example, at 2500 feet, give three quarters the normal exposure; at 5000 feet, two thirds; at 10,000 feet, one half, and at 15,000 feet, one third.
- Q. In developing roll film in a tray by the sec-saw method, I frequently have trouble in getting the film into the solution evenly. Can you suggest a remedy?—W. B.
- A. Simply immerse the film in water before starting development. This will have no effect on the latent image but will make the film limp. Developing will then be even and you will avoid the possible danger of having air bubbles form on the film.
- Q. I would like to study photography, especially motion picture work. Will you please suggest some schools? I would also like to knew what company sells motion-picture equipment.
- -S. C. A. Two schools which have special departments for the study of motion pictures belongraphy as the New York Institute of Photography, 10 West 33rd Street, New York, New York, and the American School of Photography, 5501 Michigan Arenue, Citagon, Illiands. Both schools offer resident and correspondence courses. A card

addressed to the schools will bring literature and complete information.

Motion-picture equipment may be purchased in practically any photographic any ply house. Some of these companies are listed in our advertising columns. They will be glad to send catologues and prices if you will write them.

- Q. Do you'know where I might find a table showing emulsion speeds of various films recorded in both Din and Weston, or a table to convert Dir readings?—W. W. M.
- A. In the United States, film emulsion speeds are rated either in Schenner or Weston. Din ratings are used in Europe. A conversion table that includes American Schenner (as distinguished from European Schenner (as in Industrial in Practical Speeds Films and Plates). It is of film that the American Mesion, Din, and Elasto, a list of film and Plates. It is of film that the American is the second speed of the Speeds (as Industrial Industri
- Q. I have an old 9 by 12cm Bakelita film-pack adapter in which the grooving has broken off, causing light leakage. I understand that it cannot be repaired. What would you advise?—A. H. W.
- A. Since the adapter was molded in one piece, special growing machinery would be needed to put it in working order again and this is obviously out of the question because of the cost involved. The only remedy is to have a repair man fit a 3½ by 4½ kit into the broken adapter. While the size of the negative is thus reduced, the difference is rather slight.
- Q. Can you supply a formula for making a gum similar to that used on postage stamps which I can apply to the backs of small prints and which will need simply to be moistened before use?—H, C. M.
 - efore use?—H. C. M.
 A. In five ounces of heated water, stir:
 10 ounces of fish glue or liquid glue
 - 5 ounces of liquid glucose 5 ounces of denstured alcohol

Few drops of carbolic acid

Thin the resulting solution with water to
the desired consistency and brush the backs
of the prints. If the prints are to be trimmed,
apply the gum before trimming and trim
after the gum has dried.

- Q. I am undecided whether to purchase a camera taking only roll film or one equipped only for filmpack and cut film holders. Can you give pros and cons as to which is more advantageous, roll film or filmpack?—
- activating costs, rott time or impacts are activated by a fill produced than roll film, although with practice the than roll film, although with practice the than roll film, although with practice the thin roll film is caused to loaded almost as quickly; furthermore, the roll-film type of causes requires opening the camers to load. Roll film is easier to develop because an entire roll may be developed at the same time. In the case of filmpacks the films have to hendfeld individually, although tanks are available for developing them all at most activation of the roll films and the roll films are the films of the roll films and the roll films. The roll films are roll films and the roll films are restored are for foundation than still films.



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TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker Conducted by ALBERT G. INGALLS

URKING in the rearmost cell of the average amateru telescope maker's brain is the hope that someday he may work up to a full 20" reflector, and a number of telescopes of that size are known to be in the making. The cleance of the control of the c

Figure 1: 2200 pounds of trim telescope

flector shown in Figures 1, 2, and 3 was built by William Buchele, 2832 Sagamore Road, Toledo, Ohio, who pervously had made two smaller saces. Modesly, Suchele at first sent in magazine but one small photograph accome. The instrument shown by that photograph looked so good that he was rivited to put modesty ande and write down the details about this telescope, ance these will be of value to other amateurs who plan telescopes of this size.

"Your letter," he replied, "puffed me up a bit and, if I do any bragging, it's your responsibility. I started telescope building about three years ago, using a borrowed copy of the first edition of 'Amateur Telescope Making.'

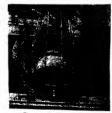


Figure 2: The Porter split ring

That's when my trouble started, and I haven't been the same since. After making the two smaller instruments I ohtsind a 21" Pyrex disk weighing 100 pounds and, at the end of about 40 hours' work, I had it roughed

end of about 40 hours' work, I had it roughed out to 1/5. Fine grinding took six hours, polishing nine. The was all done by hand, the 100-pound murror face-down over a full-aized tool and polisher, and I would not advise any one to attempt this unless he has an elephantine physique, [A. W. Everest also did the —Ed.]

"Figuring was done with small tools, mirror face-up. The correction is within 1.5 percent of a full paraboloid and the figure is smooth and regular, the performance good.

"Both the convex secondary and the diagonal flat are of Pyrex; I turned down 8" diaks to 6½" to gain extra thickness. In correcting the convex I used Hindle's method, and a sphere to figure the flat.

"Hindle's 18-point flotation system (Figure 4) was also used to support the mirror, though I doubled its number of inner edge supports. Figure 4 also shows the outer edge support shoes. The cell is a combination of steel plate and castings, welded, as is the lower part of the tube.

"The lattice-type tube (Figures 1, 2. 3) is bolted to the solid part. Its



Figure 3: Octagon hoops and spider

eight pieces of tubing are of 1½" dissurer, 23-page vall, odd-rolled steel. The 3/16" its rods and the perforated octagon hoops also are cold-willed steel, the latter (Figure 3) being made of 16-gage channels. A ½" washer was brazed into each corner of the octagon and the tubes were then presend through these bloss and brazed, makpressed through these bloss and brazed, makwhich the tube rests. Figure 2 best shows the pairs of additional tube breess stretched



Figure 4: Cell. Flotation system

over the squared ring at the top of the solid part of the tube. These give added rigidity I can detect no flexure by visual inspection of the mirror reflections.

"For the spiders (Figures 3 and 5) to support the secondary murrors I used saw-blade

"The dechnation axis trunnions (Figures 1, 6, 7) are castings of special material, (cast iron, nickel steel), as are the four other large parts of the mounting. All were normalized before mochinies. I under my applications of the mounting
before machining. I made my own patterns
"As I own no lathe or drill press I was
forced to have the lathe and similar work
done outside.

"The declination bearings are used truck ball bearings (radial thrust, 5" O.D.). They had to be large because the trunnions were to be hollow to allow the reflected rays to pass through to the eyepleces.

"I placed the declination circle with its shielded light (Figure 6) on the west side. It is divided into half degrees. The index con-



Figure 5: Lower spider, Cell, Prism



Figure 6: Declination circle. Eveniece

sists of a bright copper wire. On the east side is a reversible slow-motion motor with gearing (Figure 7), mounted on rubber. A small clutch allows this axis also to be moved manually without adjustment or disengagement of gears.

"For the south polar axis I used a radial thrust, self-alining type of bearing (Figure 8). The bearings under the split ring (Figures 2, 3, 9) are used auto parts. The inner race is stationary, while the outer race rotates under the big ring. This gives a fourpoint support, spread over a large part of the ring. Each pair of rollers is pivoted, and this tends to cancel out possible irregularities on the bearing face of the ring. "The RA. setting circle (Figure 9), is

divided into minutes.



Figure 7: Dec. slow motion motor

"The principal gear train for the drive in R.A. has a 1/8 H.P. synchronous motor (Fig-ure 8), mounted on sponge rubber. Slow motion in R.A. is obtained by a reversible motor operating through a clutch, as in the declination axis drive. This is mounted on the under side of the large worm wheel beneath a side of the large worm wheel beneath a housing. The large circular object in Figure 8, near the worm wheel, is a guard to protect

the gear, also the clothing.

"A 2½" prism, shown dimly beneath its cell ring and above the spider in Figure 5, is used to direct the image to either of the eye-pieces at the respective end of the declina-tion axis, simply by turning the priam cast or west one half turn. Very construction ob-serving position is thus made possible. "As a finder turn of the construction of the rotathle tube (Figure 1). "My coherentory (Figure 10, 11) was made by adding if to our garage. The telescope rets on place (Figure 12), with footing if deep. The observatory facer is 6½ shows the used to divert the image to either of the eye-

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THE BEGINNER'S CORNER

IITILE ways of doing common, operations, downed and used by different workers, are extremely numerous; escaredly any two doe a job alike, in fact. Ed. C. Rizzo, R.F.D. I, Cold Spring, Ky., tells how he makes laps. In a wooden mold I? wide, 24' long, 36' deep, lined with wax paper, he peels the paper of and, in a warm rown, cuts the strip into I' squares. Each of the four aides of each againer is then cut with a reunder of each againer is then cut with a re-

entrast curve, the result being a prepared facet, shaped like a four-pointed star. These are attached to the warmed tool with terps. The object of the star-shaped facets is that, after cold-pressing and swelling out, such a shape becomes a source; while a square, as commonly used, tends to become a circle. Whether a lay made of squares is superior to one made of circles is a separate question.)

To make a pitch lap free from bubble holes, Edward Lenard, 4835 N. Austin Ave. Cheago, heats the pitch in a double both stirring it often; then removes the inner receptacle and holds it 6" ahove a low flame until the pitch is thu enough to pour readily, surring all the while.

TELESCOPTICS (Continued from preceding page)

garage floor and is 11' square, grying ample room. The housing for the telescope rolls off on a gantry (Figure 10), and is so compact that, when closed, it is scarcely noticeable from the street.

"The sidereal clock (Figure 13) was made from an ordinary pendulum clock. For the pendulum I substituted a longer and compensated pendulum, thus reducing the speed of the hour hand to one revolution per 25 hours. On the dial face is a star map, and stars at the zenith are indicated at all times by the hour hand.

"For the benefit of any faint-hearted apprant for a 20", you may say that I am not an engineer, neither am I a mathematician my school training was very elementary.

"Our local Toledo Astronomy Club is an

"Our local Toledo Astronomy Club is an active one Professor Winslow, of the University of Toledo, is our skipper and we meet monthly at the University."

ETTER from an author:
"In our article, "Some Applications of



Figure 8: South bearing and drive



Figure 9: North bearings, R. A. circle

the Schmidt Principle in Optical Design," by D O Hendrix and myself, in the August number, it was certainly far from our intention to deny credit to anyone to whom credit is due. The meaning of our offending sentence would have been clearer had it been phrased to read \(^{\chi}\). It little that was not known to Schmidt' instead of 'little that is new.'

"Through private sources we know that Schmidt himself had derived the fundamental equation and had considered various



Figure 10: Garage. Observatory. Gantry



Figure 11: It all folds up snugly

modification of the principle to meet there quirements of special problems. Had we were considered of the second o

-- 1988." --- William H. Christle.

SURVEYING the durability of aluminized and chrome-aluminized mirrore, in



Figure 12: The two massive piers



Figure 13: Buchele, Sidereal clock

the June, 1939, Astrophysical Journal, Robley C Williams of the University of Michigan, after questionnairing 16 observatories, states in an 11-page article that "the most probable useful life of a coating of either of the films is from 21/2 to upward of five years, depending upon the excellence of the coating, its care, and the degree to which it is subjected to condensed moisture and dirt particles.

lu the July number of the same journala professional astronomer's journal than which there certainly is no whicher-occurs the statement that the new Skilling and Richardson "Astronomy", reviewed in Scientific American for August, is "the best single book available for teaching a large amount of astronomy to the uninitiated student," in flattering agreement with our own review.

Dave Woodbury, a T.N. whose book, "The Glass Grant of Palomar," on the 200", is reviewed elsewhere in the present number and who lives in Ogunquit, Maine, is now lecturetouring here and there among clubs of amateurs, using a heavy assortment of lantern slides. He has also lectured before Rotary Clubs and even Women's Clubs, but here he tempers his technicalities to the shorn lambs.

WHO can excel the record of C. P. W Dayton, Lyford, Tex., for telescope pier? His is 2200' deep! Because his locality is underlain by a 40' stratum of quick-and, trains moving within five miles of the telescope caused serious shiminying. An 8' concrete pier made it worse. He felt whipped. Then came an oil company, drilled a 9000' well on his land. Dry hole. But it wasn't a total loss, for Dayton found that, when he set his telescope on the 2200' of 10%" casing the drillers had left cemented in the bowels of the earth, the telescope had the stability of Palomar. Seismoscope becomes telescope.

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REGAL HIGH-LIGHTS

Patent, Trade Mark, and Related Legal Proceedings That May Have a Direct Effect on Your Business

By ORSON D. MUNN, Litt.B., L.L.B., Sc.D.

New York Bar

CRAWLING BABY

THE representation of a crawling baby, when used as a trade mark, is deceptively similar to a representation of another, even though different, crawling bahy, ac-cording to a recent decision of the Court

of Customs and Patent Appeals.

A prominent manufacturer of habies' rubber pants sought to obtain the registration of a trade mark featuring the picture of a crawling baby and in which a second baby was pictured in stooping position first baby. The registration of the trade mark was opposed by another manufacturer of babies' pants who owned a registration featuring a baby in crawling position. The Court recognized that the two marks were different in detail but held that the dommant feature in each mark was the representation of a crawling bahy and that unless the marks were placed side to side there was a danger of confusion. Under the circumstances the opposition was sus tained and registration of the first mentioned trade mark was refused.

CHINESE-AMERICAN

FEW Americans realize that the United L' States maintains a court in China where certain of the rights of American citizens and of American corporations in China are determined.

One of the recent cases decided by the United States Court for China involved the well-known American trade mark Coca Cola. Suit was brought by the owner of the trade mark Coea Cola against a competing manufacturer selling a somewhat similar product under the name of Eddie-Kola. The Court concluded that the name Eddie-Kola was confusingly similar to the trade mark Coca Cols and granted an injunction restraining further use of the name.

In the Court's opinion it also appeared that the name Coca Cola was registered as a trade mark in China in Chinese characters and the Court pointed out that the defendant had voluntarily agreed to discontinue the use of the registered Chinese

SIPHON CAPSULE

THE configuration of an article is not proper subject matter for the registration of a trade mark, where the configuration serves a useful purpose. This is illustrated by a decision of the Court of Customs and Patent Appeals involving a capsule containing compressed carbon dioxide to be used for carffonating water in rechards the soft alphons. The capsule consisted

of a tubular bulb having a peripheral groove on one side of the central portion. The manufacturer of the capsule contended that the groove constituted a trade mark and he attempted to register it in the United States Patent Office. The Commissioner of Patents denied the registration on the grounds that the groove served a useful purpose and the decision of the Commissioner was affirmed hy the Court.

In reaching its decision the Court referred of this character, in which it stated the groove served to hold the capsule in proper position in the holder provided on the soda Under the circumstances the court stated.

"We are unable to escape the conclusion that the groove as an entity possessed utility and, for that reason, under the authorities, is not a proper subject for registration as a trade mark."

CLEOPATRA

THE personal habits of the famous Egyptian queen, Cleopatra, were discussed in a recent suit for patent infringement. The suit was filed by the owner of a patent for a cleansing cream containing milk and it was charged that the defendant had infringed the patent by making similar eleansing cream. One of the defenses raised was that milk served no useful purpose in the cleansing cream and that in order to be patentable an invention must be useful rather than frivolous. In answer to this defense the patentee contended that milk ap-plied to the skin tended to whiten it and referred to the legend of Cleopatra taking daily milk haths claiming that this made her "the only white woman in a darkskinned race

The Court, however, rejected the legend as a myth, held that milk did not have a whitening effect on the skin, and declared the patent invalid. In this connection the

court stated: "But it is well known that milk does not have a whitening effect; that the story of Cleopatra and her milk baths is a pure myth."

MEIN KAMPF

THE well-known book, "Mein Kampf." hy Adolf Hitler, is at present involved in a legal struggle in the Federal Courts. The publisher of an authorized edition of the book owned the United States copyrights thereon and brought suit against the publisher of an unauthorized edition. Pending the final determination of the suit the Court was asked to grant a preliminary injunction restraining any further distribution of the

orized version. The injunction was opposed by the publisher of the unauthorthat the copyright was obtained Adolf Hitler was not a citizen of any country but, on the contrary, was stateless and on the further grounds that Adolf Hitler had not formally signed his copyright.

The trial court denied the injunction but appeal was taken to the Circuit Court of Appeals which held that the United Copyright Law broadly extended the right of copyright to both aliens and citi-zens and that no restrictions were placed upon a person who was stateless. The only restriction or limitation was placed upon an alien who was a citizen of another country. Under those circumstances it is necessary that the alien author either he domiciled in the United States or that he be the citizen of a country which extends re-

ciprocal privileges to American citizens.

With regard to the title to the copyright the Court of Appeals held that Adolf Hitler had delivered the manuscript to the publisher's predecessor in title and that the delivery of a manuscript under such eireumstances constituted a transfer of the legal title to the manuscript. The injunction was accordingly granted pending the outcome of the trial

CO-PENDING

HAT is the effect of an earlier patent, which discloses but does not claim an invention, upon a later patent granted to the same patentee which does claim the invention? This question arose in a recent suit involving a patent for a method of forming rubber tires. It was contended by the defendant that the patent in suit was invalid because the same invention was disclosed in an earlier patent granted to the same patentee. The Court rejected this contention, however, pointing out that the applications for the two patents were co-pending in the Patent Office and accordingly the earlier patent did not form part of the prior art and did not affect the validity of the natent in suit.

CONTEMPT

ORDINARILY, a person violating an injunction restraining the infringement of a patent cannot be placed in jail but is merely subject to a fine which is intended to indemnify the patentee. This is illustrated by a recent suit involving a patent for a frozen confection. On consent of the defendant an injunction had been entered restraining the defendant from infringing the patent. Thereafter, the owner of the patent contended that the defendant had violated the injunction by continuing to sell infringing articles and instituted proceedings to have the defendant adjudged in contempt of court.

The trial court found that the defendant had violated the injunction, adjudged he was guilty of contempt of court, and com mitted him to jail. An appeal was taken to the Court of Appeals and the decision of the trial court was reversed. The Court of Appeals pointed out that the contempt lings were prosecuted by the attorney for the patentee and accordingly were proceedings for civil contempt as distin-guished from criminal contempt. In civil contempt proceedings the court held that a party could not be committed to jail.

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CONTRIBUTING EDITORS

- IACOB DESCHIN, A. R. P. S , Amateur P.
- PACALE DISCRETT, A. R. P. S. Amateur Photography.
 CHURCHILL EISENHART. Department of Mathematics, University of Wisconsin Statisticias, Wisconsin Agricultural Station.
 MORRIE FISHBEIR, M.D. Editor of the Journal of the American Medical Association and of Hypers.

- Hypia.

 WILLIAM K. GREGORY, Professor of Vertabrate Paleontology, Columbia University
 E2001 A HAUSMAN, Professor of Zoology, New Jaway College for Women
 ALDEMAR EARM PFFERT, New York Times
 D. H. KILLEFFER, Chemical Engineer.
 IRVING LANOMUIR, Associate Director, Research Laboratory of the General Electric Company, Schemondry.
- E. BUCKIANAN, Jr. Dweeter of Research, M. BUCKINSH. Disector, Lindhing Research, W. ARRINOTON CHUBB, Dweeter of Research, Learn Dearly of Research, Learn Le
 - History.

 RUSSELL W. PORTER, Associate in Op Instrument Design, California Institute
 - nology W. D PULESTON, Captain, United St J. B. RHINE, Associate Professor of Psychology. Duke University. Chairman, Research Committee, Boston Society for Psychia Research. PHILIP H. SMITH, Industrial Research.
 - R. A WILKINS, Vice President and Dire Research, Revere Copper and Brass, Inc.
 - R. W. WOOD, Professor of Experimental Physics Johns Hopkins University.
 - VLADIMIR & ZWORYKIN, Director, Electronics Research Laboratory, RCA Manufacturing Company, Victor Division.

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SCIENTIFIC AMERICAN

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NINETY-FIFTH YEAR •

ORSON D. MUNN, Editor

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RESUILDING a river through a congessed business and industrial district, as was done with the Los Angeles River (see page 254), nocesitates a wide variety of engineering ingenuity. Our cover illustration shows a cantilever type of wall section, to be poured in place. Walls of this type were used in the Los Angeles River project where the right-drawny was narrow and the channel had to make a wartical section to a trapercial section to a

SCINETIFIC AMERICAN November 130. Vol To 18, No 9, entered at the New York, N. T., Post Office as accord class matter June 28, 1979, under the self affacts 7ct, 1879, Additional enter 1 of create, occur produced mortally by Manna & Company, Inc., 54 West 40th Stream, Very York, City, Copyredaded, 1370 by Manna & Company, Inc., Orest Striato nearwest Subscription 1970 1970 1970, Copyredaded, 1370 1970, Copyredad

50 Years Ago in . . .



(Condensed From Issues of November, 1889)

CANAL—"The Nicaragua Canal Company, after exhaustive preimmary surveys, horngs, etc., and the preparation of complete maps and profiles, has now started in on actual work. The total length of the route, as finally located, vs 170 unless, of this length, 121 unless is free navigation of Lake Nicaragua and they say long key, experiment only a little developing and improvement; 22 inities of the company of the company of the company of the company leaving 23 unless only of canal excavation. There will be five locks, two on the eastern, three on the western division.

MILITARY BICYCLES—"The art of war is now borrowing from applied science all the resources that are at the latter's disposal, and there is nothing up to velocipedism that is not contributing to the service of the army ... The illustration shows a phase in the use of the military bevele as practiced in England, the illustration of



which we borrow from the Illustrated London Neux. A small body of cyclust, ten in number (two sections and a half-section), with officers and bugler, marching in usual order of half-sections—that is, by 'twos—are attacked by cavalry. At the word of command, 'llait!' Prepare for cavalry!' Form square!' each man dismounts; and the respective second ball-section meve up alongside their first half-section, so as to form a line of four men in front and cart, with a half-section of two men between them. —The rifles are liked out of their clips as the machine are . . . placed upside machine, sets his whole popularies road with a touch of his finger. Such a fence, apart from the cheuser de fives of baycout behind it, forms an obstacle which few bores, if any, would face: and the men inside, in perfect security, can pick off the advancing horsemen with deadly effect."

AUSTRIAN 'PHONE-"Long-distance telephonic communication was opened on October 1 in Austria between Vienna and Prague, a distance of 220 miles. Every subscriber in Vienna can now communicate with Prague, and every word can he perfectly understood and the voice recognized."

EFFICIENCY—"After a steer goes into a slaughter house nowadays, the only thing that is wasted is his dying breath, and if it were possible to find some use for that, no doubt it would be caught and preserved. Nothing else is wasted, from the tip of the tongue to the brush on the end of the tail."

BRIDGE.—"The Illinois Central opened in \$2,50,000 bridge across the Ohn River at Cairo on the 29th ult. . . . The bridge proper is 2 miles long, and the approaches 4 miles long. The bridge is 38 feet above high water, and 110 feet above low water. The piers are in pocumatic caisons, and are auties 50 feet below the bed of the treer. . At this depth below the river bed no foundation was reached, and ty ass impossible to shir the prest further. They were consequently packed with sand, and the immense bridge is really sustained by the friction of the sand on the sides of the piers."

ARMOR PIERCING—"At the Paris exhibition the firm of Holtzer show a shell which pierced a steel plate 10 inches thick and landed entire without a flaw 800 yards, or nearly half a mile, distant from the target. Only the point of the shell was slightly distorted."

AFRIAL PHOTOGRAPHY..."A new use has been found for the carrier pigeon in Russia...carrying negatives taken in a balloon to the photographer's dark room."

IRRIGATION —"A large force of men is at work constructing an irrigation canal fourteen miles long, to irrigate a tract of 50,000 acres in Fream County, California. The canal will be 60 feet wide and 6 feet deep. This tract of land will be cut up into 20 acre farms and placed on the market."

ARCENTINA—"The Argentize Republic is growing at a really remarkable rate, Burnes Ayres, its capital, having a population of nearly half a million. In 1888 it had foreign commerce of 2200,650,000, of which \$112,41,000 represented imports, including \$44,000,000 coin, and \$106,280,000 exports. Its demands for supplies for the construction of railroads, which, in 1887, were only \$3,500,000, rose in 1888 to \$13,500,000. Of agricultural products, its exported in 1887 212,572,200, against only \$8,431,356 the previous

WELDING—"The Thomson Electric Welding Company, at their Lyna works, have . . . been able to weld wire cable 15/16 inches in dameter for a cable to be used on a cable ralitread, aboving greater efficiency than was thought possible in doing this very difficult work. Although the strength of joints obtained by spikleng was about thirty percent that of the original cable, yet it was found from tests made at the Watertown areasal of electric welds made of this cable that eighty-seven percent of the efficiency of the rope inself had been obtained in these welds."

JAPAN—"Let us take a glance in the direction of Japan. Here we are assumished by the wonderful progress she has made since Perry's expedition, and especially during the last twenty years. Here power and prosperity are steadily increasing. The recent adoption by Japan of a constitutional form of government was a great advance in the path of progress, and marks a turning point in her history. Japan is destined to be one of the great states of the future."

PULLMAN—"The . . Pullman's Palace Car Company . . . is now supplying with sleepers 117,854 miles of the 160,000 miles of railroad in the United States . . . The total number of employes of the company is 11,063, and these employes received in wages nearly \$6,000,000 during the past year."

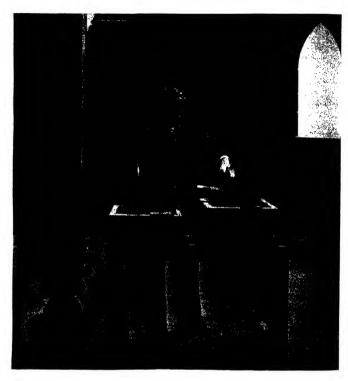
AND NOW FOR THE FUTURE

¶Is Light Slowing Down? Fundamentals of Science Rest on the Answer. By Donglas W. F. Mayer.

The Klystron, Ultra-High Frequency Radio Generator, Makes Flying Safer. By Andrew R. Boone.

"Life's Debt to Death: How Plants Struggle for the Perpetuation of the Species. By Edwin R. Bogusch.

Horse-Trader Solomon and the "Pittsburgh" of Palestine Which He Built. By Nelson Glueck.



LIGHTNING IS TRAPPED AND DISSECTED

SGIENTISTS have almost literally snatched bolts of lightning from the skies with the device pictured above. Installed atop the 24-story Cathedral of Learning in Pittsburgh, by Westinghouse engineers, it is called a fulchronograph because it measures both time and amperage of a lightning stroke, broken into tury buts for analysis. Already it has captured one bolt lasting 1/60 of a second and having a maximum current of 21,000 amperes. Its heart is a slotted wheel—filled with projecting laminated magnet steel films—which is rotated through two coils which earry the total surge of lightning that passes safely through a new type of arrester Because of the speed of the wheel and the number of fins, the device can make a recording every 40 millionths of a second. It will give valuable assistance to engineers perfecting power line protectine equipment.



No sincerce is a motor expedition through the Sahara. Though the great desert (Sahara means "desert") is very largely rock and not the traditional sand, enough of it really is sand to provide a motorist's nightmare. Note steel channels under wheels

A Lost World Refound

The several hundred thousand years man of the lover and modile Paleslikith Age roamed over the tercovered expanses of what a now the Sabara, trapping game and chipping stone implements of fixed, almost unchangeable, design. Then the rainfall dwindled, probably because of the final recession of the ice-cap over northern Europe. The people were forced to accommodate themselves to the changed conditions.

We know nothing of the details of human movements during this enormous period, and very little even of the out line. At some unknown date, many thousands of years ago, the people of the North African plains began to domesticate cattle and to pasture herds in the thinning vegetation. Later on they learned to eat cereals as well as meat, and ground some sort of wild grain. These changes appear to be connected in some way with the development of the Noslithio culture with its bewildering variety of stone implement types.

Then, very recently, between 5000 and 10,000 years E.c., there came a further stage of desiccation. The great plains stage of desiccation. The great plains dired up and were abandoned. Man migrated to the highlands bordering the desert where more rain still fell, and to the banks of the river Nile where they could grow gain without the need of any zain at all. Here began that settled life which, attunized by contacts with

On a High Plateau Far in the Sahara's Isolation, Archeologists Have Discovered Evidence of Early Man's Culture... A Land Formerly Wet and Fertile

By MAJOR R. A. BAGNOLD



A sketch-map showing the route of the expedition from the Nile 500 miles to the west into deserts so uninhabited that the trip seemed like a visit to a strange planet

more advanced communities in the east and northeast, very soon gave birth to the great civilization of ancient Egypt. Archeologists have concentrated largely on this last settled phase, but no funds have been available for a systematic examination of the old mother-lands, chiefly because the Libyan Desert is so vast and waterless that, until recently, prolonged and detailed work far away in the interior was thought impossible.

This great desert, roughly the size and shape of India, is indeed overwhelming in its lifeless silence and its sandy desolation. No vegetation of any sort exists except in the ones, for even a sprinkling of rain now falls on any one place less often than once in ten years. Seeds carried by the wind may germinate after a rare shower, but they quickly die in a ground whence all the fertile humus has long ago been blown away. The oases lie at the bottoms of deep and wide depressions, often surrounded by cliffs. They have been sexuaded by cliffs. They have been sex-

cavated by the vind down to the level of the underlying artesian water which originates in rainfall far away on lands outside the desert region. The osage mearest to the Nile and to the Mediterranean are large, and support a permanent population, but the majority consist merely of a few date palms, some swamp grass and reeds, all struggling to live in salt-encrusted soil. Some are mere water-holes which become filled with sand and have to be dug out a fresh by travelers needing water.

But even the water-holes are from 200 to 400 miles apart. Between them stretch bare rock plateaus, dead-flat sheets of sand a single one of which may be 5000 square miles in area, and ranges of giant sand dunes running straight and continuous for hundreds of miles. One or two ancient and now disused caravan routes cross the corners of the desert from one oasis to the next, but it is unlikely that any Bedouin tribes have roamed over such a landscape since the final drought overtook it thousands of years ago. For, without grazing on the way, no camel can do a tourney of more than 350 miles, or 15 days, without water; and half such a journey is an

AN expedition by car into the interior resembles a voyage of discovery at sea. With three specially equipped light vehicles a party of six can be self-contained as regards motor fuel for 1400 miles, and can remain for long periods out of reach of water. Though tire marks persist in some places for 25 years and longer, there are no regular beaten tracks; and for fear of losing their way travelers prefer to steer their own route. keeping a dead-reckoning course by day, and checking their position by the stars when camped for the night. Water is sealed in four-gallon cans, and may be kept in depots for many years without ill effects. One quickly becomes accustomed to a daily water ration of only

four pints. Kit and equipment are cut to the hare minimum to save weight for essential supplies. No tents are carried; one sleeps well on the open sand, without fear of attack by man or beast, by insect or microbe. The air is keen and envigorating in winter. Yet great caution and forethought are necessary. A party stranded beyond walking distance of an occupied oasis can have no hope of surveys?

Within the last 15 years many such expeditions, led at first by the great Egyptian explorer Prince Kemal el Din. and later by the writer and others, have penetrated westward from the Nile beyond the frontiers of Egypt, even as far as the Thibesti Mountains 900 miles across the desert. The object, being largely geographical, great distances-4000 to 7000 miles-were covered rapidly on each occasion. As a result, the curtain of mystery and legend that had hung over the country since ancient times has been lifted All the major geographical features, including the existing oases and the low-lying areas where water might be found near the surface, have now been mapped, albeit rather hastily. Some idea, too, of the immense wealth of archeological material had been gained

In 1938 a new experiment was tried out successfully. A party of nine men,

Cave paintings in red, white, yellow. Age unknown--probably between 4000 and 6000 years, yet unused pigments lay on the ground below, just as the artist had once left them

Below: Top of the Gilf plateau, showing some of the cliffs, 1000 feet in height, which surround this odd, remote world set stop of another odd remote world in the desert's fasiness



including the Egyptologist O. H. Myres and three native diggers, was enabled, through the generosity of the late Sir Robert Mond, to spend two months in a detailed examination of one promising area lying 160 miles from the nearest well.

In the very center of the desert, and at the extreme south-west corner of Egypt, lies the solitary mountain of Uweinat. Northeast of it, just visible on the horizon, the level of the yellow, featureless plain rises abruptly by a continuous 1000-foot wall of cliffs, for all the world like some black forbidding coastline, to the isolated plateau of the Giff Kebir.

The general outline of the plateau had already been mapped roughly from below, and its cliffs had been traced 150 miles northward till they disappeared under the mighty billows of the Sand Sea dunes, but neither the deep winding creeks and fiords which were seen to penetrate the outer wall, nor the upper surface beyond the flat monotonous skyline of the cliffs, had ever been explored. Though now completely waterless, it seemed most probable that the extra rainfall induced by these highlands would have continued to support a remnant of the old population long after the plains below were dead. If so, much interesting archeological material



was likely to be found. Our hopes were justified to an almost embarrassing ex-

tent. The expedition was indeed a journey into the past. For in this country time stands still. Nothing changes; nothing has been disturbed. The Neolithic grinder yet hes in the hollow of the stone quern, just as some Stone-Age woman left it ages ago. The very hearths are there, strewn about with beads, trinkets, and household tools. The ashes look no older than those of a modern Bedouin encampment. On the walls of caves under the great cliffs there still survive the vivid paintings of the ancient people themselves. One sees folk clad in strange primitive garments engaged in lively dances, and tending cattle that would now find no single blade of grass. In the same caves, and on the rocks

nearby are older paintings and cruder incised drawings of far earlier peoples shown hunting beasts that have long since disappeared.

This timelessness constitutes a difficulty, for one never knows into what age one has by chance arrived. Our first camp beneath the cliffs, sited among remains of a Neolithiic folk whose date was guessed as about 5000 n.c., was found to border also on the dim past of 200,000 years ago; for it lay on the edge of a much larger settlement of Acheulean man whose distinctive and well-known Paleolithic implements covered an area of more than a square mile of country and mingled with those of the later age.

For the first three weeks, while the archeologists were at work on these sites, two of us with a single car threaded our way along the bottoms of each, in turn,



A dry valley penetrating into the Gilf plateau. A car, seen as a dot behind two rocks jutting out of the sand within the circle, gives the scale of grandeur



Left: On top of the Gilf plateau today are tracks made thousands of years ago. In all this time there has been nothing to change them: an almost wholly static world

of the long gorges that pierce the Gilf plateau, mapping as we went. Always the same towering cliffs hemmed us in. Counting all the branches and ramifications of the valleys, the total cliff frontage must exceed 2000 miles, yet nowhere apparently could a route be found by which a car could be driven to the top; and we despaired of ever being able to survey the "Lost World" above. At last, however, a very tall sand drift was discovered whose upper slope spanned the final hundred feet of overhanging rock. After four abortive attempts to charge up it with our car unloaded, the skyline suddenly fell away: we were upon a rock surface even flatter than the plains below.

To our astonishment a row of cairns already marked the spot, and well-beaten tracks led away into the mirage over the unknown table land. We had unwittingly hit upon a pass probably last used by the Stone Age people when the lifeless yellow plain below was green.

D URING the days spent on its top the cill forced upon us the complete illusion of living upon a cliff-girt island rising from mid-cosan: the endless succession of headlands, all of even height, the cliffs beneath them falling shear from the flatness of the landscape without preliminary drainage alopes, the

limitless plains 1000 feet below, so far down that their blurred yellow features fade away into the shimmering haze. Even more striking was the steady booming of the wind that sweeps continually over the plateau and swirls away into space over the edge of the cliffs: nothing could better imitate the roar of breakers on a distant beach.

There grew also an uncanny fancy that the ancient people were still about —that there was nothing between them and us. The place has the utter remoteness of another world. One felt suspended high above the desert below, itself many hundreds of miles from the nearest habitation. The surface is a harsh barrenness of broken rock. Yet a network of paths cross and re-cross it. Lines of stones are laid out in curious patterns, as if by children playing at forts. Implements and stone flakes are everywhere; near the cliff edges the ground is literally covered with them, some blackened by the sun, but others so fresh they might be yesterday's chippings. We expected at any moment to witness the return of their makers, uncouth figures clambering up the skyline of the cliffs, hammer-stone in hand. to resume their eternal rock-breaking.

Life during those two months was by no means uneventful in other respects. Violent sandstorms broke upon our little camp, which was once nearly buried, in our absence, by the shifting of a nearby dune. On three occasions we heard the famous "song of the sands," each time in the stillness of the night. Without warning the whole ground reverberated for many minutes with a loud and low-pitched hooting that issued from the surrounding dunes. Operating 200 miles away from the rest of the party two of us became stranded owing to a serious accident to our one car. and had to walk 25 miles to a pre-arranged rendezvous with the others, carrying all our supplies of water and food on our backs. But, to the writer at least, the most lasting memory of the expedition doubtless will be a trivial incident which happened in a cave in which we had taken shelter for the night from the cold wind. The beam of a torch fell on an artificial rock ledge. On the ledge lay a solitary stone knife left behind by the last occupant untold centuries ago, just as we ourselves would em: 'our pockets before going to bed.

[The "booming of the wind," described by the author, is due to myriads of acolian whispers—alight sounds in the vortexes in the lee of minor obstructions but the "song of the sands," also mentioned, is not clearly understood by

scientists.—Ed.] This expedition has proved the possibility of archeological work under the worst desert conditions. Years of patient work will be required before the complex story of man's wanderings in North Africa can be disentangled. It is to be hoped, however, that the evidence so marvelously preserved can be collected while it is still intact, before the adventurous sight-seer has unthinkingly rifled the sites of their most important implements, and before the artist, intent on copying the precious wall paintings in the caves, has trampled on the contemporary floor relics which alone can correlate the paintings with the implement sites outside.

RIVER REBUILT TO CURB FLOODS



os Angeles River during the flood of March 1938. Abrupt curves, where river breached and caused damage, have been straightened

NDER conditions existing until recently, according to Major Theodore Wyman, Jr., U. S. Engineer Department district engineer, a great flood would practically cut off access to the city of Los Angeles, with its population of 1,500,000. In fact, Major Wyman

pointed out that the wide plain on which Los Angeles is situated is under a more dangerous flood menace than any similar region in the United States.

Accordingly, Army engineers and the Los Angeles County Flood Control District are literally rebuilding the Los Angeles River, a stream which, in 40 miles, experiences a fall equal to that of the Mississippi River between Omaha, Nebraska, and the Gulf of Mexico. Rebuilding the river is part of a broader flood control

plan. Already Los Angeles County has spent \$60,000,000 in building parts of the protective works. Present plans call for an expenditure of \$70,000,000 more. But amounts of money to be spent give no idea of the engineering difficulties and problems involved; not only must flood waters and debris of the discharging flood be curbed, but also as much water as possible must be conserved to replenish ground water storage. The life of much of southern California depends upon such stored waters

Work to date, recommended by the Board of Engineers for Rivers and Harbors and approved by the Chief of Engineers, has been done at points where floor danger was most imminent. In foothill areas, some 600 basins and Engineers are Protecting Los Angeles and Surrounding Area . . . Flood Control and Water Conservation Dual Aim

By ANDREW R. BOONE

dams have been constructed to trap water-borne debris and to check water traveling at high velocities; channels trol the water flowing from hills and on the coastal plain, enlarged, straightened, and provided with bank protection, or enclosed within reinforced con-

crete channels. The major drainage system of this area is formed by two main channelsthe Los Angeles and San Gabriel Rivers. These are interconnected by the Rio Hondo, through which water from the

have been constructed to conthese basins Below the footvarious channels have been

upper San Gabriel flows into the Los Angeles River. In general, these rivers have their headwaters in the San Gabriel Mountains, a portion of the Sierra Madro range.

Most important of the streams, insofar as their rampages may affect concentrated population, is the Los Angeles River. This stream, 70 miles in length, may be bone dry in summer, and then carry water at the rate of 90,000 cubic feet a second through downtown Los Angeles during a winter flood. Hence, to save congested areas within the city proper, as well as outlying areas, the improvements proposed for the river include construction of a leveed channel from its headwaters to the ocean; construction of three flood-control basins: and channel improvement in two washes which empty into the river, as well as on other tributaries.

Most dramatic, perhaps, are the straightening, widening, and deepening of the river within the congested district

Left: Placing steel for buttresse

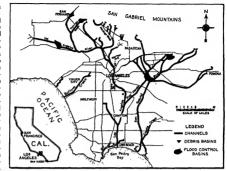
used where vertical channel walls merge gradually into sloping walls

Below: Construction in a congested



area, with mountain on one side and railroad yards on the other. The channel bottom is being paved here

of Los Angeles. Were you to follow the river from its headwaters (see map) you would first come upon an excavated trapezoidal earth channel for a distance of some eight miles; a gunite trapezoidal channel for 5.3 miles above the junction with Tujunga Wash: a concrete and rock paved channel from this wash 7.6 miles to the junction with Verdugo Wash; and a trapezoidal channel with concrete slab or grouted rock bank protection from about this point 6.8 miles to Dayton Avenue, with a special concrete section at the inlet of Verdugo Wash. From Dayton Avenue, the channel traverses the congested business and industrial districts for a distance of five miles. Due to limited rights-of-way available and the proximity of main-line railroads on each side, channel dimensions vary throughout the reach. At some points the channel must be deepened, with consequent faster stream flow. From Soto Street to the sea, several methods of construction apply.







wide with side walls 31 feet high, has been provided. Herc, velocity is figured for 83,700 cubic feet a second at about 14 miles an hour.

From many points of view, re-building this fractious stream presents engineering novelty. It is only part of a larger program, however: that of saving both life and property over a wide area of southern California and conserving water that agriculture and industry may not suffer. How well the engineers have built only time and flood can tell.

Left. Settling basin at junction of Verdugo Wash and Los Angeles River, showing baffles (foreground)

> Below: Baffle walls built across the channel (in right foreground) are to guard against over-scouring

Graceful transations are made from inclined to vertical walls. In some sections rip-rap may be hand-placed and grouted, concrete being poured down a spout from a paving machine or delivered via boom and bucket. Elsewhere, reinforced concrete slabs may be placed over derrick stone. Again, a transition section of reinforced concrete slab buttresses merges a trapezoidal section, which a vertical wall section, the latter perhaps of cantilever type which is poured in place.

During flood, it is anticipated that velocities through the downtown area will vary from 10 to 24 miles an hour, speed depending upon the section. For example, for a distance of 1900 feet, a cotangular concrete obtannel. 177 feet



TERMITES OF THE SEA

TRESTLE crashed, dumping a train into San Francisco Bay. Nearby, a ferry slip mysteriously collapsed. At Provincetown, Massachusetts, a fish pier fell into the Atlantic. A bridge keeper's house, supported on piling driven into a river that feeds Boston Harbor, tumbled into the water. All of these mishaps, and thousands of others like them all over the world, were caused by the tireless burrowings of the Teredo, a marine creature so fragile that it all but defies human handling, yet sturdy and persistent enough to honeycomb the toughest woods-teak, mahogany, eucalyptus.

Few of man's tiny enemies wreak such destruction. In three years, the Teredo did \$5,000,000 worth of damage to Boston Harbor; in a four-year invasion of San Francisco Bay, 225,000,000. It now seems ready to attack the richest, biggest harbor of all—New York.

This swift, secret destroyer has been with us for centuries. The ancient Greeks and Romans called it the ship-worm, and sheathed their flighting vessels with copper against its ravages. Only recently have we discovered exactly what it is, bow it lives, and how its depredations in our harbors can be prevented. The world's battle against it centers in one cheerful, unorthodox man, William F. Clapp, and in the scientific campaign waged by his selfless, happy-go-lucky laboratory in an old barn in Duxbury. Massechusetts.

The true research worker is often marked almost in infanor. By the time was 12, young Clapp had an excellent collection of insects, anakes, and shells. In his freshman year at Harvard, he had no difficulty getting a job as assistant curator of mollusca. Taking only those courses which interested him made getting a degree difficult—he has none to this day—but quickly won him a permanent appointment to the faculty. He taught at both Harvard and Massachusetts institute of Technology, and laid the groundwork for the new science of biological engineering.

FOR 15 years he was chiefly engaged in classifying specimens, makind hose minute examinations which determine whether a given anail or shellfash belongs to a new species or is only a variety of a species already recognized. He might have remained permanently absorbed in this specialized corner of pure science but for a queer piece of wood that was sent to him in 1920.

This specimen of timber came from a

Worm-Like Mollusk... Honeycombs Piling, Timbers... Biologist Studies It In Barn Laboratory... Records Its Depredations... Advises on Protection

By J. D. RATCLIFF

dock in San Francisco, all but eaten away by some marine "termite." What had destroyed it? Those who had sent it wanted to know. After careful study, Clapp named the shipworm of history. Teredo Nayals, as the culprit.

Impressed by his diagnosis and his report, a Committee of the National Research Council, formed to investigate the



A pile from Chelsen, Massachusetts, showing the result of a beavy marineborer attack, especially at mud line

damage done by marine borera along the United States coastline, invited Clapp to join them as a biologist. Confronted by an intriguing practical problem, Clapp maharked on a piece of research which has taken him far beyond his early years of classification and nomenclature in universities and made him a uniquely useful specialist to whom great industrial companies come crying Filologist, silogist, save my dock."

Some people think of research as a peaceful, well-rewarded profession conducted by untroubled men in long white costs working in laboratories supported by great foundations. Nothing could less resemble the conditions under which William F. Clapp has waged his war on

the Teredo. His laboratories have been as makeshift and fugitive as a Kentucky moonshiner's still. One laboratory was a total loss because the harbor over which it was built suddenly was polluted by the seepage from oil tankers Then he set up shop in a 60-year-old schooner, donated by friends, which he fitted up as a marine laboratory, and which the Coast Guard obligingly towed from place to place. When the decrepit schooner sank, be had to begin again Now the general staff, and the intelligence service with its priceless records of the doings of the enemy, Teredo, in all parts of the world, are housed in an old barn. There, in an atmosphere of casual simplicity and hard work, Clapp and his staff of seven young technicians -at \$25 a week-are learning all there is to know about the immense destructiveness of minute animals.

LIFE in the old barn is insecure, hand to mouth, enthusiastically singleminded. Marine borers are discussed with the same vehemence that other people discuss the New Deal-and sometimes that vehemence is all that keeps them warm. One winter the laboratory was so cold that a railroad official found the workers wearing their overcoats. As the railroad company had benefited from their research, it shortly sent a check for \$1000-enough for a new heating system. Equipment is often lacking, but if needed badly enough it somehow appears, and a compound microscope, or a filing cabinet, or a pressure heater for experimenting with wood preservatives, miraculously falls from heaven.

Invaluable specimens and records are stored in this pitifully infammable barn Here is a collection of marine borers larger than those of all the museums of the world put together. Here are individual records of a million individual wooden piles, detailed data on the fluctuating activity of horers in hundreds of harbors. Everything known about the Teredo—as well as fungl, rats, termitesrusts, and other destroyers of structural material—in-croorded here. And a great deal has become known since William F. Clapp entered this atmost unexplored

field just a bit more than 20 years ago. The Teredo, which looks like a greyish-white worm, is actually a molluskar relative of the oyster and the claim. This tribe, together with the crustaces (the family of lobsters, crahs, and shrimp) boasts thousands of species of whose differences would interest only the biologist, but whose one common point is of painful concern to owners of property on salt water: they chew their way mut wooden pilling, leaving no visible entrance on the outside, and tunnel until, very often, it unexpectedly collapses.

A pile which seems quite solid may contain tens of thousands of borers, some as much as six feet long. Bored beams and piles which look virginally sound may be broken over one's

may be broken over one's knee. The Teredo can ruin a costly wharf in as little as two months. It also destroys the planking of boats, and has been known to eat through hawsers, cutting yachts adrift.

Teredos are launched into the world as free-swimning larwe; minute in size but immensely promising. Sea currents will deposit some of them on rocks, some on the mud bottom, and some on wooden pling. Wherever they land, they instantly answer some urge of instinct and start burrowing. Right: Stages in the life of Limneria, a marine borer. A shows a grown female; B, very young specimen (note dark eye); C, Young; D, Immature

Directly below: Still another marine borer, Chelura terebrans, photographed enlarged

Bottom: Teredo Navalis, which sometimes attains a length of six feet. P.P. are the pallets through which food enters and waste is thrown out. S,S are its grinding shells





thick and hard that it cannot be broken by the strongest fingers.

One burrow may approach those belonging to other creatures of its kind, but they never merge. Perhaps only a lime-coated membrane of wood will separate tunnels but each will maintain its discreet identity. The Teredo may bore directly through a timber but it will never bore through to the open on the side opposite its entrance.

When the constant rocking motion of its head has worn out one set of den-

ticles—or teeth—Teredo sprouts another. As many as a hundred rows of these microscopic teeth have been found in one of these creatures. Delicate as they are, no structural wood has yet been found dense enough to resist their borma action. Some varieties of Teredo can even cut their way through poorly mixed concrete.

WHETHER the sawdust Teredo consumes a tile a food is a matter
of dispute. Multipute of agree. He maintains that Teredo on agree. He maintains that Teredo on agree. He maintains that Teredo on the tile of the sawdeenture in home building, and that he
subsists on plankton, the properties of
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of water determines the span of each
of water determines the span of each
works the year round. An untreated
tumber which would last 30 years in Labardor may last only one year in Panama.

Why will these borers suddenly invade a harbor which has been unmolested for decades? The answer usually lies in changed conditions. A three year drought explained the infeation at San Francisco. With very little fresh water going into the Bay, salinity rose and the borers went to work to do staggering damage. Particular attention is now being centered by Clapp on New York



Those that land on mud and rock quickly perish. Those that alight on timber are more fortunate. After two hours of furious work their minute heads, shaped like clam shells, have rasped away a shelter deep enough to enclose the entire body.

As it progresses from the embryonic to the adult stage, the Teredo becomes a rather complex and impressive creature. It sheds the fragile shell with which it does its boring and grows another which is more sturdy.

The Terede maintains contact with the outside world, which is to say the sea, by two hair-like branches of a forked tail. Through one it sucks in saw water and food in the form of minute sea lik and through the other chantes its body wastes. The opening through which those two siphone sextend is no larger than a pinhead, but this portal—a superbly constructed valve—will serve Toredo even though its body attains a learnt of six form.

length of six teet.

Teredo is a master architect, and a superb housekeeper. It removes all debris by the only means at its disposal: by eating it. It lines its tunnel neatly with lime. In some cases this tunnel is so



Honeycombing of a pile by marine borers in only two years, despite the cold waters of Newfoundland

Harbor. In the past, pollution of this port has been so great that borers could not survive. When the present clean-up program is completed, they will almost surely arrive in large numbers and go to work. Such a thing happened elsewhere, notably at Lynn, Massachusetts.

Keeping track of borer activity in a hundred harbors scattered throughout the western hemisphere is the monumental task the Clapp Laboratory has set for itself. Are borers on the increase in Puerto Rico? And what varieties are at work in New Brunswick? Are they harmless ones which work in water too deep to damage piling, or the destructive Limnoria? To answer such questions Clapp's endlessly active mind has devised many ingenious aids. One of them is a test block which gives a continuous record of borer activity; another is a trap which captures specimens for identification.

THE test block is engaging in its aimplicity. It consists of nine small
blocks of pine—ideal Teredo fodder—
bolted to a strap of iron. Each month a
block is removed, and a new one is bolted
in its place. Biologists examine the
block in the laboratory and compare it
with those removed from the same spot
at earlier dates. They can thus determine whether borer population is rising
or failure.

The Teredo traps consist of 30 shingles bolted together. Since the borers refuse to cross a crack, they confine activity to a single shingle. When the bundle is unbolted, whole specimens may be removed examined, and identified.

Test boards are kept at over 400 stations, and traps at scores of others. Maintenance of a board costs about \$5 a month and a few companies pay for this service, but the great burden of expense falls on the laboratory. Test boards occasionally reveal a tremendous upsurge of borer population. In severe cases, as many as 100 Teredos have been found boring within a single cubic inch of wood. Such cases demand instant attention. Several times Clapp has found it expedient to telegraph dock owners quickly to remove all valuable goods from their property because their docks were in danger of collapse.

Once test boards indicate that bores are at work on the piling which supports a large dock, a diver gove down to make an examination. Some of the divers who work for Clapp are so learned that they even know the Latin names of the commonest bores. With astonishing accuracy they can estimate the amount of damage and from this the structural strength of supporting material left under the dock can be calculated.

Corrective measures are determined by local conditions. Where damage is severe, piling must be replaced. Some times concrete corsets are poured around partially damaged piling. Sometimes



The exterior of a badly bored pile gives an appearance of solidity

they are covered with metal sheathing. Damage to the vast, 825,000,000 Army Base in Boston was so severe that Clapp recommended that bulkheads be built which would completely enclose the substructure of the dock, and that fill be then pumped m. This fill prevented further activity of the borers, some ready access to salt water is necessary for their existence.

If timbers in new construction are pressure-tracted with good quality crossote they get complete protection. But in some cases the quality of crossote in so low and method of application so had that even this treatment a valuelesas. The Clapp Laboratory tests the protective power of these materials. Through ignorance or false economy, hundreds of thousands of untreated piles are still being used in United States harbors. As a result, docks last only a third as long as

they should and must be replaced often.

Still, one good word can be said for marine borers: without them the world would have no open harbors. Long ago harbors would have been clogged with rotting driftwood if the borers didn't destroy this debris.

to the beauties of the state of

"TRIENDS are always attempting to T make me change my ways," says this genial biologist. "They want me to keep books and send bills and do things like that. But I'm damned if I will. I am a biologist, not a bookkeeper."

If a check arrives and Clapp feels that he has not carned the sum sent, he returns it. Officials of a large sugar company called for advice about a new dock A telephone call saved them thousands of dollars and they sent a \$500 check in appreciation. Clapp returned it. Not reminite telephone call, he contended, could be worth that much. Another time he refused an annual retainer of \$15,000 from a company which made a wood unservative.

The pleasant, blue-eyed biologist has done practically everything to the Teredo-except eat one. He hopes to get around to this some day. Meanwhile he goalong adding up new facts whose application will save millions of dollars. The aboratory had a zazable deficit last year. It took in \$11,000 and spent \$13.000. But Clapp is not deeply concerned. "If your work is good enough," he feels, "weeple cannot afford to let you fail."



A Teredo tunnel in a luminated block, showing the partition always

OUR POINT OF VIEW

Battle is Joined

HOW long World War II may last is anybody's guess. How difficult it is going to be for the United States is a different matter. Though not involved, we shall, nevertheless, be faced with a problem of defense against forces that are insidiously subtle. It is not our war, vet our fight to stay out of it will call into play all our forbearance, all our common sense, all the skill of our government.

As this is being written, the war in Europe is but a few days old. Radio and the newspapers have, however, given us already a vast amount of propaganda and counter-propaganda. One side of this war behind the war will have little effect on the individual for he will have formed his opinion prior to the outbreak of hostilities, but the propagands from one's chosen side will tend to strengthen his belief in the righteousness of one cause. Inflammatory rumors will have their influence. Logic may be forgotten and emotion will rule. Hatred may become a neurosis, and the multitude may then clamor for blood, may insist that we enter the fight with men and guns. This we must guard against with all the might of whatever logic and sane thinking are left to us.

The United States is today in a fortunate position in respect to world politics and power. Our foreign commitments relate wholly to the American hemisphere. We have a battle fleet second only to that of Britain, and a large program of ships building and planned. A plan has been launched to train thousands of air pilots each year, and the personnel of our Army and Navy have been in-creased and rendered more efficient. More planes have been ordered to be delivered over a period of years to our military forces. Mechanization of the Army is proceeding with the efficiency that comes of deliberate care. Construction of scores, perhaps hundreds, of new American-type tanks—the best in the world-goes on apace. Slowly all infantrymen are being equipped with the world's finest rifle, the Garand semiautomatic.

The so-called "Stock Pile" Act, passed by Congress last spring, is enabling us to store up necessary vital products against a time of need when imports of them may be cut to a point lower than is at present possible. A War Resources Board has been formed of scientific and industrial leaders. Industry has long since been so organized that, if war should be forced upon us, each plant could quickly and efficiently go on a

war-time footing, "Educational orders" have been given to many of them. Other things, important to us in war, bave been mentioned recently in these pages. For example, there is the new process of molding airplane fuselages, which would increase our plane production enormously. Another is the sizeable supply of manganese from Cuba.

This magazine has long been a proponent of the philosophy of "preparedness for peace" and believes that the above review, sketchy though it be, indicates that particular and important kind of preparedness. Our might is vastly greater than in 1917, our organization so superior that there is no comparison Hence, it is our belief that no nation will wittingly antagonize us, insolently dare us to go in on the opposing side. It is ourselves that we must watch lest we become dupes of silver-tongued agents who would embroil us in troubles out of our own bailiwick. We may give our sympathy-which is of the heart-where we will; but through it all we must keep our heads .- F. D. M

Communication

AT first thought it would seem that the peculiar techniques of radio broadcasting-spot news, high-geared commentators, and so on-would give the whole world a grandstand seat in the event of war. But when the situation grew tense in central Europe, when fateful September 3 rolled around, the humming of the air waves brought thinking people to the realization that a communicating system was more than falling down on a job; it was providing a medium whereby misinformation strode side by side with information, and no sieve was offered through which they could be separated.

The preceding editorial hints at the propaganda possibilities of radio. But there is much more to the story. Operation by belligerents of stations under faked call letters, spurious dispatches, "blanketing" of legitimate stations-all teach us that we will do well to take radio news broadcasts, at least for the duration, with more than the proverbial grain of salt,-A. P. P.

Howling For Knowledge

DOZEN years or so ago it was ascertained by means of polls conducted in the interests of the press that the branch of science which "pulled" hardest with the general newspaperreading public was the one having the least practical usefulness-astronomy.

This startling discovery astonished the newspaper world. Since the press is the reverse of stupid, it gives the public just what is asked for and it therefore greatly increased its regular ration of features and news stems on astronomy. This astronomical emphasis has been going on in the press for a decade or so and now it is bearing a heavy crop of fine fruit. The masses, and no longer merely a limited number of better-thanaverage educated enthusiasts, have now become strongly astronomy conscious.

In Chattanooga a small group of advanced amateur astronomers recently pooled their efforts to make possible a public observatory, whereupon thousands and thousands of people-just average "folks"-visited and continue to visit that observatory. Mountaineers have tramped in from the distant hills to see the stars through a large telescope for the first time in their lives

Not long ago David Dietz of Cleveland, science editor of the United Press, a man who has one foot in astronomy, the other in the newspaper world, decided to make a test of interest in astronomy among the masses and put on a public star party Ten telescopes made by amateur astronomers in Cleveland were rounded up, placed in a public park, and directed at different celestial sights; one at Mars, another at Jupiter, and so on. Previously the event was announced in local papers. Would the party be a failure? Would the people take one look and amble off home? Would they come at all?

More than 5000 people stood in line till after midnight awaiting their turn to see what these objects, about which they had been reading in their papers for years past, look like. Patiently? No. Cleveland had to send two squads of police to keep them in line. Pop venders appeared out of nowhere and did a rushing business. When, at 1:30, the last eager star-gazer left the park, it resembled a battle-field, littered with paper, Crackerjack boxes, bottles.

Only a howling mob? Yes, but not a disorderly one—just eager. Only tabloid readers? Probably largely so. Is that bad? No-all to the good!

These successes give answer to those persons, schooled but essentially ignorant, who still insist on rating everything on a basis of its practical usefulness. It's a mighty good sign when 5000 of the plain people will stand in line and vell "Hurry up" in order to get a better idea of man's place in the universe: for that is suspected of being the real philosophy behind it all .- A. G, I.

Hunting The Mesotron

WHEN confronted with the eremounting clutter of assorted
atomic and authority particles
brought to light by photolists in recent
years, one naturally resolution to continue the reyears, one naturally resolution to continue the resent particle as a might a bug collector hounding down
a specimen, or do the particles merely
fly in through the window one day and appresent themselves? Let us consider,
for example, the latest problem particle
in physics—whe mesotron.

Although there has been considerable controversy as to where it is found in nature, it is now known that the meso-tron occurs only in the cosmic rays. These rays, which rain in upon us constantly from outer space, have been known for many years. Nevertheless, the question as to just what they were was not settled until scentists turned to the Wilson chamber with which they proposed to study their true nature.

The Wilson chamber consists of a shallow glass cylinder covered with a glass plate. The interior contains a small amount of liquid, such as water or alcohol, which evaporates, filling the chamber with vapor. In the bottom is a piston which, when suddenly pulled out by a suitable mechanism, causes the vapor to expand and condense. If the expansion is very carefully adjusted so that condensation just fails to occur, any electrons or other charged particles which traverse the chamber will leave faint tracks of condensed vapor in their wake. By photographing these tracks, much can be found out about the nature of such particles. For example, their velocities can be found if the chamber be put between the poles of a large electromagnet. The effect of a magnetic field upon a moving charged particle is to cause it to be deflected in a direction perpendicular to the magnetic field and to its original path. Thus the track will be bent by the magnet into a circle. The radius of the circle is proportional to the momentum of the particle and, since momentum is the product of mass times velocity, knowing the mass, the velocity can be found.

At first, experimenters merely set up their chambers and expanded them at regular intervals, hoping to eatch cosmicracy tracks by accident Considerable miprovement was made in getting photographs when Geiger counters were used These instruments consist of a thin metal cylinder surrounding a wure and put in side an evacuated tube. High voltage is This Recent Addition to the Fast-Growing Family of Sub-Atomic Particles has Already Created a Place for Itself in Physical Theory and Experiment

By CHARLES W. SHEPPARD

connected between the wire and the cyl inder and adjusted until just helow the point at which a discharge will occur if a cosmic-ray particle shoots through the tube, the discharge is set off and can be made to trip an electrical circuit, expanding the chamber With such an arrangement, it is possible to catch a cosmic-ray track at every expansion



Figure 1: Two cosmic-ray showers, one in the chamber wall and one in the plate, show that particles from showers produce showers. Each particle has an energy of several billion volts. (See the text below.)

In practice, two counters are used, placed one on each side of the chamber and connected in such a way that the chamber expands when the particle goes through both. Thus, the chamber operates only when a track goes right through it.

The study of coame rays with the Wilson chamber was immediately fruitful. When a barrier of lead was put into the chamber, many pictures aboved a strange phenomenon. A coamic-ray particle entered the chamber from above and went on into the lead plate. It merged from the other side and with it, like an explosion, came a regular forest of other particles (Figure 1),

Such occurrences are called showers. Up to this point, the result had been quite straightforward. There was good reason to believe that the tracks which were observed were caused simply by clectrons. In particular, a study of the shower particles showed that those produced by showers could themselves produce showers, and their energy loss in going through the lead plates showed that all were electrons However, the many workers on the cosmic-ray problem frequently observed other particles, and although their tracks looked just like electron tracks, they behaved in a different manner (Figure 2). To understand why the scientists were puzzled by these other particles, we must consider how charged particles lose their energy in traversing matter.

LET us consider first a fairly heavy hydrogen atom, called the proton. Since the distance between the atoms in a plate of lead is about 100,000 times the size of the proton, the latter cannot lose energy by friction in passage through it, as would a bullet in a plece of wood. It is known that almost all the energy loss which a proton suffers is due to the electrical forces that it exerts on the electrons in the material through which it passes. About thirty volts of energy are needed to pull an electron from an alr molecule. The number of these dissociated air molecules, or ions, can be measured and it is found that, in air, a proton of 1,000,000 volts energy creates so many of these ions that it loses almost all its energy in less than half an inch of air. In the case of lead, it will scarcely penetrate at all. Energy loss by ionization, as this type is called, is characteristic of heavy particles which do not move with very high speeds. Although the process is very complicated, it has been found that the energy loss is greater the slower the particle travels, and a measurement of the rate of energy loss gives an approximate idea of the velocity of the particle.

A totally different type of energy loss is also known. Particles such as electrons, which are light but travel at high

speeds, lose their energy by giving out electromagnetic waves when they pass through matter. This is how the rays are produced when the electrons in an X-ray tube strike the target. This type of process is called energy loss by radiation.

From what has just been said one can see that a study of the way in which a charged particle loses energy should give quite a bit of information about it. Such energy-loss measurements were attempted but were hard to make. The energies of cosmic-ray particles run in billions of volts. Such particles move so fast that none but the largest magnets will bend their paths enough to permit measurement. However, careful work gradually yielded the necessary information. As the measurements slowly accumulated, suspicion grew into certainty. Those tracks which produced, or were produced by, showers lost energy in just the way that electrons may be expected to do and were undoubtedly electrons. On the other hand, those tracks which occurred without showers were different. for they had a penetrating power very much greater than any other charged particles beretofore known. Of the many experiments to demonstrate this penetrating power, one of the most spectacular, in which the particles were made to pass through more than seventeen inches of lead, was made by Street, Woodward, and Stevenson, at Harvard University.
In 1937, Dr. Carl Anderson and Dr.

In 1937, Dr. Carl Anderson and Dr. Seth Neddermeyer, of the California Institute of Technology, put forward a tentative explanation in a paper published in The Physical Review. This paper contained a plot of the energy



Figure 2: "Picture" of a mesotron. The particle comes in with high speed, making a very faint track, slows down in the central plate, and emerges going more slowly, as is shown by the heavier track as well as by the sharper curvature.

losses of cosmic-ray particles, showing how the non-shower particles lost much less energy than the shower particles (Figure 3). Let us suppose, they said, that the unknown particles are heavier than electrons but lighter than protocome will travel saster than protons and not lose much energy by soinzation. On the other hand, they would not travel so fast as electrons and would not lose much energy by redistion. This would explain their low energy loss or great penetrating power.

In order to substantiate their theory, it was thus necessary to determine the mass of these partueles. The difficulty lay in the fact that only the momentum can be measured when particles are deflected by a magnet. The mass is known only when the velocity can also be found. Several workers at once attempted to measure the velocities of the unknown particles by the following method:

A charged particle traversing a cloud chamber leaves a track because of the ions it produces in its path. The vapor in the chamber prefers to condense on these ions, and with the right expansion, every ion picks up a tiny droplet of condensed vapor. If the expansion can be delayed a fraction of a second after the particle passes through, the ions will have time to drift apart so that the droplets can be counted with a microscope. If the number of ions in each centimeter of track is counted, the rate of energy loss can be determined and this will give an approximate knowledge of the velocity of the particle. Such measurements are actually a good deal more difficult to make than a description would indicate. Conditions must be just right and not every picture will do. However, in 1937, Street and Stevenson, and, shortly afterward, Anderson and Neddermeyer, obtained the pictures they were looking evidence extending back over several years. Measurements of the mass of the particles from these pictures showed that they were somewhere between one and five hundred times as heavy as ordinary electrons. Several suggestions were made for naming the new particle and Dr. Anderson's suggestion of mesotron received the most support.

SCIENTISTS had scarcely had time to inquire as to what place there was for the mesorron in existing theories when a bolt from the blue came in the form of an already existing paper in the rather maccessible Proceedings of the Physico-Mathematical Society of Japan. In this paper, published almost two years before the discovery of the mesotron, the Japanese physiciat, Yukawa, had announced a theory explaining the force of attraction between the neutron and proton. The theory

stated that these unknown forces holding the atom together could be explained if one assumed that there existed a new particle with the charge of an electron but of larger mass. If, as many scientists believe, the Yukawa particle actually is the mesotron, then not only is an experi-

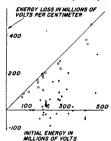


Figure 3. Principal clue to the existence of the mesotron. Diagonal time represents the total loss of energy in one centimeter of platinum plate. The circles clustering close to this line are electrons. Dots clustering near the bottom of the graph are mesotrons

mental discrepancy accounted for but also a vacancy in theory is filled by its discovery.

Needless to say, the appearance of the meetorin upon the scene has stimulated the whole field of cosmic-ray research to new activity. Experimenters are redoubling their attempts to make accurate measurements of cosmic-ray tracks using larger magnets and Wilson chambers than those formerly employed. Thus more precise information will soon the obtained with such appearatus.

Let us now return to the question we made at the beginning. Is particle hunting a sort of glorified insect collecting or does the physicist find the particle one day at lunch in his soup? In the first place, both alternatives place an undue importance on the particle itself. Such a discovery is never merely a new head to hang on the wall of the physical laboratory. Instead, it invariably represents an important contribution to physical theories and thus frequently extends human knowledge in many different directions at once. Let us consider the senior member of the "tron" family, the electron. This particle is a crucial link in almost all the physical theory devel-oped since 1875. It is safe to say that, without our knowledge of the electron, we would have no X rays, no radio. and no long-distance telephone. Perhaps one day, the mesotron will be as indispensable.

COULD WE DEFEND OUR PORTS?

Whether or not important American ports are sufficiently well fortified to stand off a possible invasion remains an open question. Only an actual attack upon one of those ports would provide the answer. The drawing on the opposite page is presented as an example of what might happen but, unfortunately, military strategy is not so sumple as that. With this drawing before us, we still must lean heavily upon past military lessons

and experience. Bombing planes cannot cross the wide oceans that surround us and still deal any effective blows against us. Hence, any invader would have to depend upon only those planes which his carriers could bring. This immediately unlifies any belief which he might have that the airplane has changed naval warfare condutions radically since 1915. In that year, the British fisseo at the Dardanelles proved rather conclusively that it is futile to launch a naval attack upon land fortifications.

We are here concerned not with why an enemy might attack us nor how he would get through our first line of de-fense—the Navy—but rather with the possible reception he would get were he suddenly to appear on our "doorstep." For this purpose, we have shown mything the suddenly to appear on our "doorstep." bunched and hence thrown out of persective for obvious reasons.

As soon as the enemy's fleet nears the city-which might not have much warning-preparations for the defense of the port will get under way according to plans long before worked out. Necessarily, these plans include bringing up more guns and equipment, plane detectors, range finders, searchlights, and many additional men from camps near the city. Firing of anti-aircraft guns would begin long before the fleet itself is in sight. Its planes, based on carriers left perhaps 75 miles out at sea, will attempt to destroy gun emplacements in the city's forts. Doubtless, they would resort to the practice of divebombing, an American trick learned by foreign aviation, oddly enough, from an American moving picture, "Hell Divers," several years ago.

This surprise attack from the air might cause some damage, but the organization of the defense would, nevertheless, proceed rapidly and efficiently. All available units of all our armed forces—Army, Navy, and Air Corps—would be co-ordinated and unified under an appropriate commander.

An Imaginary Attack on a Mythical Port Shows Sort of Action That Would Take Place

He would keep track of, and drrect the movements of, the additional forces coming up from the rear, most of which is motorized and some, as in the case of the 12-inch and the 16-inch guns, or railway mounts. These latter large guns would be run in on the railroad spur shown at the right of our drawing. The 16-inch guns on railway mounts, as well as those of the forts, would be able to match anything the enemy capital ships would have, being able to throw one-ton shells for a distance of about 40,000 yards.

Against the enemy's airplanes would he directed the fire from several types of guns. Most important would be the 3-inch guns which fire about 25 highexplosive shells per minute to a height of 24,000 to 28,000 feet. Until 1938. we had only a few of these rather small guns. In that year we added about 340 of them to our armament, and since have added more. Another anti-aircraft gun which the defending forts would use is the 37-millimeter gun. This mobile arm fires explosive shells weighing approximately a pound and, being loaded with clips of five and ten shells, has almost machine-gun speed of fire. Furthermore, low flying planes would meet deadly streams of metal from 30-caliber and 50-caliber machine guns. The Spanish civil war apparently proved that machine guns, as contrasted to those firing explosive shells, are ineffective against modern. metal-clad planes. In spite of this fact, it is believed that these efficient machine guns, properly controlled and operating in groups, could cause serious damage to planes.

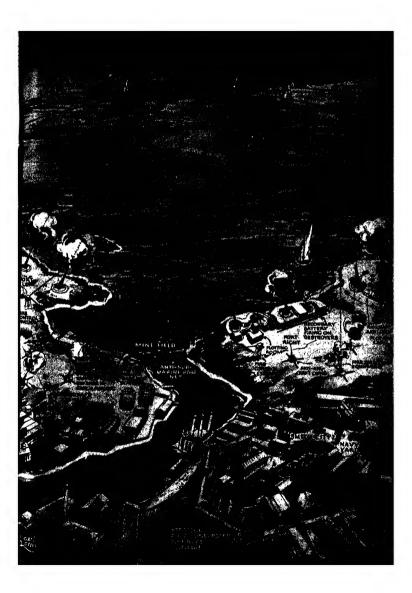
ONCE an enemy plane is detected by the defense, an ingenious range finder, shown in the drawing near the anti-aircraft batteries, would go mto action. This finder is practically automatic. As an observer moves it to keep its widely spaced cross-hairs squarely on the enemy plane, that movement actuates gun-pointing equipment to make the guns follow the plane's movements closely.

As for the fleet itself, wariness would characterize its actions because of the lessons of the Dardanelles. The enemy capital ships would form a line of battle just beyond the range of the largest guns of the forts. The advantage lies with the land guns because of their permanent emplacements which give greater stability and because their firecontrol stations can more accurately plot a moving slip's position. These fire-control stations - shown on the drawing in both Fort Left and Fort Right-form the bases of triangles while their converging lines of sight make the apex of that triangle. The exact position of the ship at the apex is therefore easily calculated, in the plotting room of Fort Right, by the mathematical process of triangulation. Planes spotting shell bursts among the enemy ships. and also "tracking" those ships to predict their movements, would provide further data.

Since the enemy's principal purpose would be to get his capital ships close enough to deliver his 14-inch or 16-inch shells in the forts, he might try to sneak in under cover of a smoke screen. This screen would be laid by squadrons of destrovers which would dash in closely in a sweeping curve, firing their smaller guns furrously. The high speed of these destroyers increases the possibility of their escape but, even if some of them are destroyed by gun fire, their loss is not to be compared with that of a capital ship. It is during their dash close inshore that the secondary guns of the defenders, hitherto useless because of their shorter maximum range, must go into feverish action.

Our drawing has its necessary limitations. We have shown, for example, only one small submarine boat net and a mine field that is actually too limited for practical purposes. These things are more symbolic than actual, for we wished to show only the essentials. In real warfare, far more ships and guns, mines and nets, planes and anti-aircraft guns and detectors would be in such an action. Also there are many other factors, too confidential or too speculative to be mentioned here, that would have a bear ing on the fight. In any case, it is believed that an attack of this sort would result in a stalemate. This does not mean that our ports are invulnerable. They aren't. It is only our ability to draw upon an immense hinterland for enormous support which could save us in such a situation. We do need more large-caliber guns, more and larger antiaircraft guns, and many other important things, but that is another story.





Eclipsing Binaries

It may be questioned whether there is really a "royal road" to the solution of any problem of nature; but some routes do lead us, with less difficulty, deeper into the regions which we desire to explore.

One of the most important of these routes, in our search to understand the stars, is found in the study of the pairs which colipse one another. It has long been realized that from good observations of these systems we can find out things not directly accessible in any other way, such as the real size of the stars, their densities, and the actual brightness of their surfaces.

But even the finer details of the lightcurves, which might almost be called the "embroidery upon the main pattern." are singularly informative.

For example, when the brightness of an eclipsing star (that is, the combined light of the pair, which could not be seen double in a telescope 50 times more powerful than any ever constructed) has been accurately measured and the light plotted against the time, it is found that, between the deep diparising from the successive eclipses of each star by the other, there is a mailler, each star by the other, there is a mailler, ecclipses, the light is hrighter than where the eclipses are just over or just ready to begin.

The explanation of this behavior (which was first noticed in the bright star Beta Lyrae) has been known for almost 50 years. When the component stars are close together, each will be distorted by the tidal forces arising from the attraction of the other. This will make them egg-shaped, with the long ends pointing at one another. As they revolve in their orbits, about their common center of gravity, they will rotate at the same rate, and continue to point toward one another. Half-way between eclipses, where the line joining the stars is at right angles to us, we will see them broadside on. At the middle of eclipse (if the orbit is edgewise toward us) we will see them end on (one behind the other), and just outside eclipse they will be nearly end-on. Half-way between eclipses, therefore, the star-disks will have a greater apparent area than just outside them, and, naturally, we will get more light.

This ellipticity effect has been found in dozens of stars—indeed, in almost all cases when the observations of light are accurate. We might expect to find it bigger when the stars are very close together—and the eclipses consequently A Striking Example of the Extent to Which the Astronomer, Armed with but a Few Observational Data, Can Sometimes Go in Unraveling Puzzles

By HENRY NORRIS RUSSELL, Ph.D.

Ohairman of the Department of Astronomy and Director of the Observatory at Princeton University Research Associate of the Mount

occupy a considerable part of the whole period—than when the eclipses are short and the stars far apart; and this actually happens

The shapes which stars, tidally distorted by their mutual attraction, would assume can be calculated. The theory is fairly simple, in the first approximation (though it becomes intricate when the bodies are very close together). It is found that the shapes depend not only upon the masses, radu, and mutual distance of the stars, but also upon their internal constitution. If the material (supposed to be fluid, so that it yields freely to the tidal forces) is all of the same density, the elongation will be large: but if it is much denser near the center than at the surface the distortion is much smaller. In the extreme case where practically all the mass is concentrated at the center, it is only 40 percent as great as for a homogeneous body.

HERE then appears to be a royal road leading us to knowledge about the inaccessible interior of the stars. As long ago as 1912, Shapley applied this method, finding that the ellipticity of such stars, derived from observation, agreed quite closely with the values calculated by Sir George Darwin for homogeneous massess of fluid.

There was, however, one difficulty. The calculations just described had been made upon the assumption that the disk of each staf (seen sufficiently magnified) would appear uniformly bright all over. Now the only star we can actually observe in this way is the Sun, and it does not look like this, but is only about half as bright at the edge as at an the center. The reason is that the light which reaches us from points near the apparent edge escapes obliquely, and on the average comes from cooler layers nearer the surface.

We might expect some "limb-darkening" of this sort in the stars also. It is not hard to calculate its effects in the case of an ellipsoidal star. If there were two stars of the same size, shape, and average brightness, one presenting a uniformly bright disk and the other darkened so as to be very faint at the limb, it is found that the difference of brightness between the end-on and broadside-on presentations would be 60 percent greater for the "darkened" case than for the "uniform." An observed variation can therefore be produced by a "uniform" star of a certain difference in long and short diameters; by a "completely darkened" one for which this difference is only five eighths as great. and by a whole set of bodies of intermediate shape and intermediate degrees of darkening toward the limb. Unless we can find the degree of darkening in some other way-which is still very difficult-we are left in considerable uncertainty about the real shapes of our stars. and the actual internal distribution of density

But now another royal road seemed to open up. If the stars are elongated as described, their mutual attraction will not be quite the same as if they were spherical. The effects of this have been known for more than two centuries. No perceptible change will be produced on an exactly circular orbit; but, if the orbit is eccentric, the line of apsides (passing through the points nearest the center and farthest from it) will slowly advance, in the direction of the orbital motion. The rate of this advance depends on the radii, masses, and ellipticities of the stars, and also on their internal constitutions, being a maximum if they are homogeneous, and falling to zero when all the mass is concentrated in tiny particles at their centers. This impossible, but theoretically limiting. case is known as the Roche model (from the name of its inventor).

If an eclipsing pair has a circular orbit, the alternate eclipses of each star by the other will come at equal intervals, and last equally long. But if the orbit is eccentric, both the intervals and the durations will usually be unequal. If the line of a paide is a moving, the intervals between the eclipses will slowly change, wringing back and derward be-

tween two limiting values, and repeating these changes after a whole revolution of this line.

For most of the stars which have been observed, the orbit appears to be circular. But in a dozen or more cases uniquelitational between successive minima prove that the orbit is eccentric, and, in allowat all these cases, the intervals are changing, showing that the line of apsides is moving. In two systems a complete revolution of the apsides has been observed.

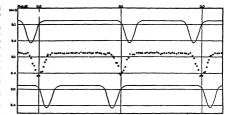
Knowing the rate of this motion, and the sizes and relative masses of the stars, we can calculate the degree of concentration of density toward the center. For the star Y Cygni—the first to be reliably observed—Dugan and the writer found, several years ago, that the concentration must be great

But sgain the once-royal road appeared to be blocked. The theoretical calculation of the attraction of the stars on one another had been made for hodies of the shapes which they would have at their average distance apart; but no allowance had been made for changes in this shape

NOT long afterward Walter went deeper into the mathematical problem, assuming that the two ellipsoidal stars weer rigidly fixed in site and shape, but free to turn on their axes unerveily, and point a little away from each other at times. His analysis led to the remarkable conclusion that, in this case, the line of apsides moved backward while two stars undergo vibrations such that their long ends oscillate to and for about the line joining their centers (usually they oscillate with different rectiods).

Given his assumptions, his conclusions are mathematically sound; but, about a year ago, Cowling pointed out that real stars, being gaseous, would not behave at all like the "frozen," rigid bodies of Walter's theory. As the distorting forces changed, while the stars moved around their orbits, the mobile gaseous masses would tend to take new shapes, corresponding to the new forces; and this adjustment would be so quickly made that it is practically safe to disregard any lag in it, and assume that the shapes of the stars are determined by the forces at the moment, and are most clongated when the two are closest together. Working out the details no simple task-he found that the apsides move forward, but at a little more than twice the rate originally calculated by the writer.

The theoretical problem has now, apparently, been cleared up. When the new equations are applied to the actual data—as has been done in detail for the best-observed stars by Sterne, and approximately, for a larger number, by the writer—it is found that, in every



Light carves of an eclipsing binary with eccentric orbit and rotating line of apsides. Phase in the orbit is measured toward the right. The distance between the two vertical lines labelled 0.0 represents a full period. Vertical distances represent the apparent magnitude of the pair of stars, a measure of their brightness. The dips in the curves are due to the eclipse of one star by the other. The center curve represents the average of all observations. In the upper curve the stars are at periastron (closest togsther) in the latter half of the period, mildway between the two minima which occur closer togsther. The lower curve around, making periastron occur in the earlier half of the period. This variation of the time interval between eclipses is due to the greater speed of orbital motion when the stars are closest together.

However, the above diagram is not immediately related to the particular stars discussed and mentioned in the accompanying article. Rather, it is shown as "a very pretty Illustration," as Professor Russell wrote in suggesting that it be reproduced, "of the changes due to locating spudses in an orbit," and it is taken from an article entitled "The Apsidal Rotation of GL Carinac," by Henrietta Swope and Harried Shapley, in the Bullatin of the Harrord Collage Observatory for July 1, 1932 (No. 999). In the absence of Professor Russell in Europe the above explanation of the diagram was prepared by Prof. D. B. McLaughlin of the University of Michigan. Regular readers of Professor Russell's articles may be interested to know how the illustrations are selected Sometimes he prepares rough tacthers.

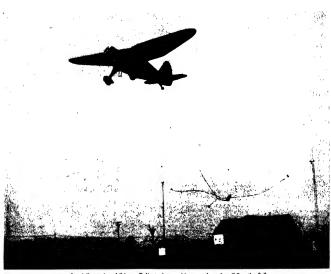
case, the central condensation is high The motion of the apaides is never as great as 6 percent and usually less than 2 percent, of the value which it would have if the stars were homegeneous. It follows, approximately, that the central density of the stars is always at least 20 times as great as the mean density of the whole star, usually more than 50 times as great, and occasionally as much as 300 times.

So far as observations of this type go, the results are consistent—though a lot more observations will be needed to get more accurate data. But an alarming discrepancy now appears between the results of the one method and the other. The two royal reads end in different places—one indicating that the stars are not very far from being of uniform density, and the other that the increase of density at the center is very great.

The answer to this puzzle comes from some theoretical work of Chandrasschhar, who found, six years ago, that a distorted star of this sort should be faintest at the ends, remote from the centerest at the ends, remote from the centerthe surface-brightness being and proportional to the intensity of gravity as this would be observed by an imaginary inhabitant of the surfacehary inhabitant of the surfaceFor such a body the difference in brightness between the end-on and broadade views is much increased—in fact, very nearly doubled. This was first pointed out, five years ago, by the late Dr. Takeda. His results were published (in English) in a Japanese scientific periodical, and escaped notice till the matter had been treated by various other investigators.

When allowance is made for this and for the effects of 'darkening' (which operate almost independently) the discrepancy disappears. The fairly large changes in light which are observed between eclipses arise largely from the difference in brightness between the ends and the middle of the elongated stars—and are increased by the limbdarkening. The real shapes of the stars are not far from those of the Roche model—just as the changes in the orbits indicate.

Much more work remains to be done before this mine of information about the surfaces and the interiors of the stars becomes exhausted. Meanwhile, it is interesting to note that our present fairly satisfactory knowledge has been reached by the work of investigators coming from this country, England, Germany, India, and Japan.



Specially equipped Stinson Reliant plane picking up a bag of mail "on the fly"

AIRMAIL FOR SMALL TOWNS

IRECT airmail service to small cities and towns, previously reserved for large centers of population where the volume of business warrants large airports and mail-handling facilities, is now daily available to 58 localities throughout Pennsylvania. West Virginia, Ohio, and Delaware. Through development work by All American Aviation, of which organization Richard C. du Pont is president, an airmail delivery and pick-up system invented by Dr. Lytle S. Adams has been reduced to practical operation. Flying the air-ways in specially designed and equipped ships, "sky mail clerks" are now able to make deliveries and to pick up mail without the necessity of landing. At the time of writing, the system is in operation with six experienced pilots, some of them of national reputation, and four "sky mail clerks" constituting the flying personnel.

The success of the system, and the

Pick-Up and Delivery Without Landing . . . Made Possible by New System . . . Can Bring Fast Mail Service to the Most Remote Areas

By DR. ALEXANDER. KLEMIN
In Charge, Danift Guggenheim School

regularity with which the service is carried out, indicate its entire feasibility. There is no doubt that it can readily be extended to other sections where its advantages are desired.

While full technical details of the exact operations of this new system have not as yet been released, the accompanying photographs and following description serve to give the fundamentals. The ground equipment necessary consists merely of two steel poles, 30 feet high, set in concrete foundations 60 feet apart.

Each pole is topped by a brilliant orange marker. Stretched between the poles, and attached by spring clips, is a trsns Ter rope from which is suspended the mail bag to be picked up.

mail bag to be picked up.

In the planes used for this service, all standard interior equipment has been removed except the pilot's seat, thus making room for mail bins, pick-up goar, and a seat for the clerk who also is responsible for the operation of the mail-handling apparatus. With this relatively simple setup it is possible to deliver and

pick up mail while flying at a speed of between 90 and 110 miles an hour. Since speed in the essence of airmail service, it is interesting to note here that, flying 1540 miles daily and making 75 pick-ups to serve the 58 communities along the route. All American Aviation's planes are carrying on a regular schedule at a werage speed of 100 miles an hour even under adverse weather conditions. Since the stations are from five to 22 miles apart, such service could not possibly be mantained if it were necessary for the plane to land at and take off from every varion.

Deliveries and pick ups are made in one trip through each station, the operation being as follows: The clerk lowers by hand the bag for delivery, which is inked to the plane by a rope ending in a release mechanism that is under the control of the pilot. He then lowers the grapple hook on one end of a cable that is wound on a shock-absorbing which in the plane. The pick-up cable extends from the bottom of the fuelsage about two feet forward of the delivery one and the two lines are prevented



from fouling by their drag/weight ratios which give them different curves in

When the delivery bag is released by the pilot, before the plane reaches the two poles and transfer rope at the station, it falls clear of the pick-up cable. The plane then passes between the poles at an altitude of 50 to 70 feet above the ground. The pick-up cable then crosses the transfer rope and slides across it until the prongs of the grapple engage the rope and pull at free from the poles. As the grapple pulls on the transfer rope, the mail bag alides along the rope away from the granule. a simple restricting



fitting slowing up the travel of the bag as it approaches the end of the tope where it is checked. It is really this slide fitting, which absorbs much of the slock of contact. that makes possible thutype of pick-up without impossing undue strain on the cable. The remander of the shock is taken up by the absorbing mechanism in the plane. It is stated that



Above: The steel grapple with which airmail pirkens are made. Left: A "sky mail clerk" operating the winch by means of which the bag of mail is recled into the plane. Extreme left: Closeup of the combined winch and shock-has orbing apparatus which is mounted in the plane. The air-oil shock absorber operates when the grapple hooks into the line and prevents undue strain being imparted to the plane listed. Before: The fiber and tracter and the plane of the plane listed. Before: The fiber and tracter and the plane that the contract of the plane listed. Before The fiber and tracter and the plane that the contract of the plane listed. Before The fiber and tracter and helps to absorb transfer energy.



the pick-up is scarcely noticeable to the occupants of the plane. Should the grapple or cable be fouled by an obstacle on the ground, a safety link in the cable will break, preventing any possible accident.

In present operations the pick-up load has been limited to 20 pounds, although loads up to 70 pounds have been successfully picked up in tests.

The mail bags used in this system have been so designed that they will trail smoothly in the air and also that they will withstand the shock of dropping at high speeds. As shown above, they consist of a smoothly rounded fiber nose with a rubber skirt attached and a mail container inside.



Looking toward the rear of the special airmail plane, showing a mail bag ready for delivery and, in background, the mechanical release operated by the pilot

Cancer's Mysterious Puzzle

"PUBLIC interest in the cancer problem is now at the highest point in history," says Dr. James Ewing, one of our foremost cancer experts and director of Memorial Hospital, New York City.

This interest is only natural. We have become aware that cancer is by far the most important public health problem. Some 15,000 die each year in the United States from this perhaps most mysterious of all man's afflictions. Cancer, it is true, is curable—to a certain extent, especially if caught in the early stages—and many are cured, or more accurately, are treated successfully; but the fact remains that many more are not cured.

The great mystery is nowhere near elucidationand on this point all experts agree. Why do some cells subtly begin to multiply aimlessly, to form an unorganized-hence cancerous-growth, which the body cannot control because the growth escapes from the unknown agents that normally keep all the tissues a unified harmony of structure and activities? Such is the problem, simply stated. Yet this simplicity is deceptive, for all man's enormous medical and bioknowledge is at a loss for the answer.

And so, any new clue to a possible answer is fascinating as well as distinctly promising. The discovery of substances which definitely have the power to induce cancer is the most promising of all recent leads—and

surely the most startling "One of the most fruitful lines of cancer research

in recent years has provided the demonstration that cancer may be produced at will m a anjority of the animals treated, with a variety of chemical compounds. For the most part these compounds have been prepared synthetically and their molecular structure is known. They retain their activity undiminished after a high degree of purification. The cancers which may thus be induced experimentally are indistinguishable in their characteristics from the cancers which afflict mankind." So we are told by Dr. J. W. Cook, the English pioneer in the realm of cancer-

Though Science Still is Baffled by the Problem of Cancer's Cause and Cure, Research Continues... Most Alluring Leads of the More Recent Years

By BARCLAY MOON NEWMAN

inducing substances, who, with his coworkers at the Research Institute of the Cancer Hospital, London, has led the world in this line of research.

The story of the discovery of cancercausing chemicals begins at least as far back as 1775. In that year, the London surgeon, Percival Pott, re-

all Mustrations courtesy United States Public Realth Service
Using the fluroscope with X rays in examination of the
chest for cancer. If there is a cancerous growth, a shadow
will be discernible on the screen in front of the, difest

marked on the prevalence of cancer among chimneysweeps and pointed out the probability that soot is the significant factor. Soot, we now know, consults a souther a consult of the consults are t

Later, other occupations besides the sweeping of chimneys were found to be plagued by significantly high rates of cancer. Skin cancer is frequent among workmen employed in the distillation of coal tar. Laborers who apread tar on roads; workers chronically exposed to shale oil and other lubricating oils, makers of certain dyes, particularly ani-line dyes; spinners an continual contact with certain oils—in each of these occu-

pations we observe a suspiciously high cancer rateoccupational cancer.

N 1906. B. Fischer injected a dye known as Scarlet R into rabbit cars. The cells of the skin, after several injections, multiply abnormally, in a manner similar to cancer cells. But when these injections are stopped, cell proliferation ceases-that is, the growths are not malignant and so not truly cancerous. This work has been extended. and one outcome is the use of Scarlet R to hasten the healing of wounds. Another outcome, as we shall see, has led by a tortuous path into the field of true cancer.

In 1911, Peyton Rous discovered a chicken tumor which not only can be propagated indefinitely by transplantation from fowl to fowl—and hence a true cancer—but also can be induced by a mysterious agent or chemical extracted from

the malignant tissue. In these labors. Dr. Rous collaborated with James B. Murphy, now Director of Cancer Research, Rockefeller Institute.

As such facts were brought to light, and the minds of cancer experts: Is a single substance involved—a lone fearful chemical which causes cancer? Great hopes, too, arose. Is the hypothetical chemical the sole cause of cancer Parhaps, it was speculated, the cause of cancer fact rall, simple—and the cure likewise simple and near at hand. These hopes have been dashed. In their place, how

ever, are definite advances toward the vast secret—for all that, the secret seems vaster than ever. Hope, if an inspiration to intelligent action, does bring results and newer, more firmly based aspiration.

In 1915, two Japanese esientitas, Yamagiwa and Itchitawa, set forth a fundamental experiment. They repeatedly applied coal tark to the ears of rabbits. Malignant growths developed. Coal tar does indeed induce cancer. Yet coal tar is noted for the inestimabily great variety of its components. To determine the guilty substance or substances would seem a herculean lahor. Nevertheless, many investigators rushed to the task

A decade later, in 1924-1925, E. L. Kennaway, of the Research Institute of the Cancer Hospital, London, produced cancer-inducing tars in the laboratory in one matance by heating acetylene in an atmosphere of hydrogen under pressure. Then an ambitious program of detective work was plotted at the Institute—for Kennaway's discovery indicated the probable chemical nature of the cancer-inducing material. Acetylene is a hydrocarbon, and the technici of the experiment apparently should yield only hydrocarbon derivatives of excetylene. Her was a priceless clue.

One by one, the known hydrocarbon constituents of coal tar were tried out on mice--a laborious procedure, involving months of work with each substance. Negative result followed negative result. The years began to go by All the known fractions were separately tested, in vain Still, the guilty agent was there in the tarry mixture-somewhere. A new conception of its potency arose. So rare, so difficult to find, the agent must be astoundingly potent in its action. Minute traces of it, beyond a doubt, could stir up a series of cellular changes having the fatal outcome of cancer.

BY 1930, however, Mayneord and Hieger perfected a special spectroscopic technic by which it is possible to relate the spectra of tars and tar fractions with their cancer-inducing powers. Certain spectra, or wavelengths, were shown to be characteristic of the tarry materials exhibiting the maximum cancer-inducing activity. A special group of chemicals soon became suspect. This group is made up of the more complex compounds of hydrocarbons-known as the aromatic hydrocarbons, and known to feature rings of carbon atoms all tightly fastened together, and with hydrogen atoms clinging here and there; all to make up an intricate molecule.

Particularly suspect was the hydrocarbon called 1,2-bensanthracene, apparently not a cancer-inducing chemical itself, but a molecule giving rise, under the proper spectroscopic conditions, to wavelengths of light impressively similar to those from tars definitely potent cancer-inducers. A logical step was next taken. Why not try the effect of chemicals having molecular structures very much the same as that of 1,2-benzanthracene?

The detectives were able to write down the formulas of the chemicals



Treatment of a cancer with radium. During perhaps half an hour this trestment may continue, the patient feeling no particular sensation

most suspect. The substances were rather numerous and many had never been seen. Dr. Cook rose to the occasion. He synthesized the desired undiscovered substances—a brilliant achievement because of the complexity of these many-runged aromatic molecules. He also made available to this colleagues, by additional syntheses, the already discovered, essential molecules.

As luck in scenece would have it, howver, the first cancer-inducing agent to be turned up was not among those hydrocarbons which Cook's originality enabled him to synthesize before any other chemist. This fact detracts nothing from Cook's extensive pioneering which has turned up dozens of cancer-inducing molecules.

Alert and co-operating remarkably, Kennaway, Mayneord, Hieger, and Cook in the course of their researches reached an utterly formidable molecule-also formidably named, 1,2,5,6dibenzanthracene. This substance they dealt with as they had with the others before. They dissolved it in benzene to make up a 0.3 percent solution. Twice a week they applied a drop to the skin of the backs of their mice. The weeks ran into months. Finally, in a large number of mice, small warts developed on the skin. The warts began to grow, many swiftly. Several frequently coalesced into a single horny mass, which, as autopsy proved, would push forth tentacle-like, hungry tissues extending down into the inner normal tissue.

When, in the future, history is written with the correct perspective, the year of this observation, 1932, no doubt will mark the start of a major epoch in man's effort to survive on his planet.

And, according to Howard B. Andervont, of the United Public Health Service and Harvard Medical School: "This epochal observation, which was the outcome of a series of brilliant experiments performed by the English workers, is an example of the results that may be obtained by co-operative efforts."

D.R. Andervont adds: "It is also an example of the way in which observations made in the one field of science may lead to important advances in other, unrelated fields, for the chemists who first synthesized 1,2.5.6-dibenzanthracene were not interested in cancer research." In 1929, an organic chemist, Clar. had reported a new and ready means of making this compound, with which chemists had been familiar for some time.

1.2.5.6-dibenzanthracene, however, soon lost its unique status-as the only known cancer-inducing molecule. Our Englishmen speedily found that 1,2benzanthracene also was cancer producing, though only feebly so They identified the active constituent of coal tar in 1933: a chemical termed 1,2-benzopyrene. And, in the past few years, from their London laboratories has come a list of more than 30 chemicals clearly cancer-producing when painted on the skin of mice. All substances giving rise to occupational cancer contain a certain percentage of one or more of these agents or of their chemical kin.

Has the cause of human cancer been discovered at last? Not by any means. Dr. Cook states:

"We are not, of course, justified in inferring that human cancer is of chemical origin. All we can say is that there are a large number of experimental observations which are consistent with the view that the factor which initiates the onset of malignancy may in some cases be a chemical compound or compounds."

The very recent story of the developing science of cancer-inducing chemicals constitutes an amazing justification for Dr. Cook's judgment. The story creally stupendous—it involves wholly unexpected relationships among life's highly diverse chemicals, relationships that are as profound as life's deepest secret. It appears that the enigma. What is life?, will as readily be solved as the enigma. What is cancer?

What mystery is deeper than that of sex? The discovery of some of the chemical messengers, the hormones, which play powerful rôles in the development of man and woman has only

made the mystery more involved-despite popular rumors to the contrary. Now the mysteries of sex and cancer have been united. Now workers in the United States become the pioneers. Edgar Allen, Professor of Anatomy at Yale University's School of Medicine. with Dr. E. A. Doisy, in 1923 showed that female sex hormone injections can start certain tissues growing with astonishing rapidity. Also at Yale, and collaborating with Dr Allen, other investigators-G. M. Smith, W. U. Gardner, L. C. Strong, and W. O. Nelsonhave advanced far along these lines. The English school has reciprocated by establishing that some of the known cancer-inducing chemicals can, in special cases, act upon the body in the very same way as certain sex hormones!

ACASSAGNE was the first to report L (1932) the production of true cancer by use of sex hormone. Mammary tumors developed in made mice after a lengthy series of injections of estrin, a female sex hormone. Large doses are required.

"This is a very significant observation," says Dr. Carl Voegtlin, Chief of the National Cancer Institute, United States Public Health Service, "since Little reports that in over 5000 mice in his colony spontaneous mammary tumors occurred only in the females and not ma single male."

Incidentally, the males take on certain female characteristics—and, like true cancers, the mammary growths can be transplanted from the feminized males to either males or females. The cancers, Dr. Allen and his co-workers inform us, after transplantation will continue to grow without additional stimulation (by injection of more hormone). Hence, we must not forget, the genetic or hereditary factor may always play a part in cancer, however induced. This consideration is a whole science in itself—another imposing history, fascinating too.

Not only mice respond to sex hormone injections Such injections produce abnormal growths in rats, guinea pigs, monkeys. Some of these growths are typical cancers. Recently, the American Medical Association warned against the use of a certain cosmetic containing female sex hormone and pointed out the possible production of cancer by repeated application of the cream. The Association has also warned against promiscuous injections of female sex hormone in therapeutic measures. There is no doubt that human beings would ultimately develop malignant growths subsequent to long-continued treatment with such chemicals. Clinical results-in which non-malignant growths have begun to show up just before treatment was halted-confirm these forebodings. (The non-malignant growths cease development and generally recede harmlessly enough upon cessation of administration of hormone.) Where the unified investigations of sex and cancer will lead, none can predict. The future is unimaginably

There is a strikingly close resemblance between sex hormones and the particular cancer-inducing hydrocarbons dis-



The X ray in action for treatment of stomach cancer, 1,000,000 volts now being used to get deep penetration, also to minimize skin burn

covered by the English scientists. Some of the cancer-producing compounds have hormone-like activity. Other physiologically active chemicals—including vitamin D—have molecular structures also strikingly like cancer-causing chemicals.

And so, naturally, there has arrsen a theory that, in some weird fashion, the normal course of chemical transformations within the tissues may be upset and, out of an essential hormone or allied chemical, cancer-producing chemicals may disastrously emerge. This theory is still, for all its apparent plausibility, little more than a guest

Y there are other lines of approach to the problem—and they suggest the theory of Dine of the most powerful cancer-producing substances is methyl-cholanthermone to the acids found in bile has a nonlinear producing substances in methyl-cholanthermone on the discussion of the producing substances are of the acids found in bile has a nonlinear producing molecule. The biochemist readily makes methyl-cholanthrene from bile meth

There is even more to puzzle us—in fact, tremendously much more. A wazlike substance, cholesterol, is present in every cell of the human body; bran and other nervous tissue are especially rich in this chemical. Cholesterol is a member of the chemical family—of related or closely similar molecular structures—to which bile acids, sex hormones, and cancer-inducing chemicals belong. Now to this group of almost belong. Now to this group of almost uniquely strange things we must addate the biochemists above us—such out and the proposed of the

Four Japanese scientists-Yoshida, Otsuka, Nagao, and Kinosito-have made outstanding contributions to cancer lore. Their successes too, nevertheless, have served only to increase the entire mystery. Yoshida demonstrated that the Scarlet R molecule, used to accelerate the healing of wounds, can be burst to yield a cancer-producing molecule, which he identified. In a sense, it was disappointing to learn that this carcinogen is not a hydrocarbon-and so is not a member of the family of the carcinogenic hydrocarbons. The future would have looked much brighter if nature had decreed that only one general type of chemical can be cancerproducing. Many utterly different classes of molecules possess the dire Dotency

IN fact, the so-called "azo compound" of Yoshida does not mduce malignant growth of the skin where presently applied or even where to receive The azo compound, fed or invected, concerned the liver and bladder. According to Dr. Cook, a related azo molecule "was shown by Otuka and Nageo to have a much more pronounced carcinoscine cation on the bladder when administered to rats with their food, but no longer gave cancer of the liver." A subtle change in molecular structure makes a great difference.

Startlingly enough, Kinosita has shown that "butter yellow," a dye hitherto useful in coloring butter and other foods and similar in chemical structure to Yoshida's carcinogen, induces liver tumors in rats. Presumably, butter tumors is discontinued in the similar of the foods has been discontinued.

Today more than 50 different cancerproducing chemicals are known. Is there any property common to them all—besides, of course, their carcinogenic activity? No. And we can be sure that, in the gloomy light of the measurcless dread of cancer, every connectiable property has been considered.

Is there any indication of how these substances produce cancer? No.

In a recent lecture subsequently published in Science, Dr. Carl Voegtlin gives us the conservative, present conclusion: "It seems wiser for the present to admit our ignorance concerning the mode of action of carcinogenic agents."

Man — Mechanical Misfit

In the Long Course of Organic Evolution Diverse Experiments Have Been Tried, Some Successfully and Some Not . . . Is Man Destined to Failure?

By G. H. ESTABROOKS

TATURE is not infallible Far from it. She blunders along for a trifling 300,000,000 years to produce a gigantic race of dinosaurs-then scraps the lot She puts in another 100,000,000 perfecting a type of mammal that makes the elephant look like a pygmy. Then, in a huff, she packs him off bag and baggage to the realm of fossils. The last 20,000,000 years she has been specializing on man and his ancestors. There are many of us who feel that she is just on the verge of losing her temper with this latest product. It may be a guilty conscience, but at times she seems to send in our direction what can only be described as a very dirty look.

However, we are not interested here in ccounting the story of evolution. Rather we wish to draw attention to certain enumering problems with which nature found herself confronted. The production even of man is a tremendous feat, for the engineer builds with only one type of brick, the cell; and there are many billions of these in the human body. To be sure, they differ much from one another in form and function but they are still cells, microscopic in size, from which nature finally constructs such monaters as whales, elephants, or men.

Let us take a very brief glance at the nature of the animal. Fundamentally he is just a gasoline-carbon-burning engine and its basic problems are few in number. When carbon burns it simply unites with oxygen, produces energy in the form of heat and leaves certain waste products behind. So nature's great problem in building an animal-engine really subdivides into three smaller posers. First, get the carbon (food) to the engine. Second, guarantee a source of oxygen and, third, remove the waste. Three neat little problems on which nature has been working for 2,000,000,000 years and is just getting warmed up, so to speak. Of course, there are minor considerations as well. She has spent a great deal of time and energy perfecting the machine, as such. Also she has had to devote much "thought" to its protection, for some animals find tha the easiest

possible way to collect a supply of food is just to eat up the fellow next door Not all these problems have been of equal difficulty. At times we can see where the whole course of evolution has been held up for one or two hundred million years while nature's experts were trying to invent a auitable carbureter, or were completely changing the ventilating system. The fuel pump (heart) has caused no end of worry and the exhaust system (kidneys) is continually causing labor trouble. Yet, for all that, the machine runs and probably will be running hundreds of millions of years from now.

TAKE the question of the fuel supply. Difficult, to be sure, but not as serious as some of the others. Nature's first animals were tiny microscopic blobs of protoplasm The ameba is a giant compared with these first attempts, but if we put it under our microscope we find that its food problem is simple. Its body literally flows around a particle of food, which then passes right through the body wall into the body itself and is there absorbed into the tissues. None of this nonsense about stomachs, mouths, livers, or such things. But life became more complex and, even in these singlecelled animals, we soon find a definite "mouth" appearing and a stomachreally a food sac. For hundreds of millions of years nature was quite satisfied with this arrangement. The animal took in food through a definite opening, digested it in this food sac, and then expelled the waste through the same opening. The sea anemone with its waving tentacles is an excellent example of this stage in the food question, although this method applies also to much larger creatures such as the jelly fish and the Portugese Man-of-War. But it was inefficient, especially when we came to larger animals.

Much more practical was the continuous digestive tube which nature first brought in with the roundworm and has used for the past 700,000,000 years in all higher models. Here the food comes in at one end of the body and follows a continuous course until the waste is expelled from the other extremity. This is one-way traffic and nature could then add livers, kidney, bile ducts, and various types of glands all along the passage, guaranteeing the proper digestion of the food, the elimination of waste, and no worry about congestion caused by back traffic.

This matter of getting food in and waste out of the whole body was not such a serious problem. Somewhat more of a poser was the question of distributing the food, once it was within the body walls. In very tiny organisms nature trusted to the principle of diffusion: the digested food would leak through from one cell to the other. But this had very definite limits. As the animals grew larger she tried the idea of side tubes going out from the central stomach These would convey food to distant parts of the body and then diffusion could get in its work. This idea was better but also called for improvement. In anything larger than a small worm it did not give satisfaction, especially in so far as waste products were concerned. So nature took a tremendous step and installed a fuel pump (the heart) which forces the food in under pressure and literally washes out the debris.

This fuel pump and the fuel lines (blood vessels) have been a continual point of worry to Mother Nature, with continuous alteration in design. The earthworm has half a dozen of these hearts, which are really only thickened and muscular arteries. Since then, na ture has followed a continuous evolution until we come to the very complex four chambered mammalian heart.

The matter of getting food into and through the body was, however, simple compared with the problems involved in the oxygen supply. Carbon is worthless as a source of energy unless an adequate supply of oxygen is always on hand, but how to get it into the body and then guarantee that each of the billion cells would get its share? All life started in the water and there is plenty of oxygen dissolved in normal water supplies. Nature's first answer was again to depend on the principle of diffusion. Gases or liquids will always tend to equalize pressure, if possible. There is less oxygen in a cell than in the surrounding water, so the oxygen in the water, because of its greater concentration, is pushed through the very thin cell wall into the cell itself. Once inside, it unites with carbon compounds, forming the gas carbon dioxide, CO,. This is in much greater concentration within the cell than in the surrounding water, so the CO₂ is pushed out again—a very neat little arrangement whereby the cell in question is assured of an adequate supply of oxygen.

However, this principle has very definite limitations. The cell or body wall must always be moist and must he very thin, otherwise this exchange of oxygen and carbon dioxide will be so hampered as to be inadequate for the needs of the animal in question. An animal the size of even a small fish needs such a thick skin to hold it together that diffusion is impossible, so nature found herself neatly checkmated in the matter of evolution until she could answer this prob-

lem of oxygen supply. Here nature showed real genius. She already had installed a fuel pump in these primitive animals, which guaranteed a supply of blood-carried food to every last cell. Why not use this same pipe line system to get the oxygen around? Only how? The answer was hemoglobin, a red iron compound which colors your blood. This substance has the peculiar power of forming a very unstable alliance with oxygen. As it passes through your lungs, forced on by the heart pressure, it takes on a load of oxygen and then literally dumps it at whatever cell has the greatest need-that is. the least oxygen pressure. Only, of course, at this stage in the game nature hadn't even thought of lungs. All life was in the water. Lungs were several hundred million years away.

SO nature handed this task of oxygen transportation to the blood stream, in addition to its already important one of transporting food. In some relatively late models, such as the insect, the blood still has no responsibility so far as oxygen is concerned. In nature's improved model it had; but how was she to get the oxygen in the water to make contact with the blood stream? After much fussing about with her old idea of skin diffusion she hit on the gill slit. Here the water flows through the gills of the fish or other water animal, propelled by the throat muscles of the species in question. In these gill slits, as you can see by examining any fish, the blood comes very close to the surface of the body, being senarated from the water only by the thinnest of skins. Here we again have the principle of diffusion. The oxygen is forced in through this skin because of its greater concentration in the water and the carbon dioxide is forced out for the opposite reason, thus guaranteeing an adequate supply of oxygen in the blood stream which transports it to the individual cells. The gill slits are the lungs of the fish, and nature was now able to proceed with evolution, having solved a major mechanical difficulty. Size was no longer restricted by this question of

oxygen supply, formerly a limitation. But increase in size immediately raised another question, You can't have animals 30 feet long which are just smasses of jelly; you must have some form of girder on which to drape this mass of muscle, tissue, and blood Obviously, hose of some sort was the an-twenty of the selection of the what? Should the selection he inside or outside the selection be inside or outside the

THE reader will note that, in the accompanying article, the anthor personifies nature: na-ture thinks, nature makes plans, nature rejects, and so on. The reader is at liberty to take this literally or he may regard it more as a convenient man speaking. Since the time of Darwin the great majority of scien-tists deny outside planning and e the amazingly intricate fitting of parts as the result of millions of years of slow actions. Every organism has the power to make certain adjustments to changes in the environment. It also has the power of adjusting itself while it grows. Organisms also vary from time to time with regard to particular features. Give this variable, adjustable organism, say, 50,-000,000 years and the fossil evidence shows that sometimes (not always) it does take advantage of new opportunities and does advance with the times. Other types remain more fixed and stable than the mountains. The anthor, in his article, selects a few of the hundreds of forms known to science and shows what happened to those that did advance from fish to

Will nature really discipline man? Or will social man with his superior adaptability receptions and head it off? Just at present he is demonstrating (in Europe) the need of the slipper. Is he corrigible? Who know?—The Editor.

water animal in question? This question was so vexing to nature that she did if both ways and then sat back to watch results—is still watching results, in fact, very critically, for if man is chased off this earth the insect may do the job, and the insect has the outside skeleton.

This external skeleton has two tremendous advantages. Physical strength is a question of attachment area for the muscles and the external skeleton affords protection. The lobster tribe and many insects are incased in a shell which is "proof" to animals at their own level.

But, opposed to these advantages, is the problem of weight. If this casing is to be effective, then the animal is slowed up by its weight despite its extra strength. It is like the knight of old without his horse, or the heavyweight wrestler-dangerous customers if they can get you cornered, but not much of a problem if you take to your heels. And nature has discovered that the very best of all protection is speed. A hawk is dangerous to a sparrow but a swallow doesn't even notice him. Both hawk and swallow know he'd be wasting his time if he started on a race. Here many insects have hit a very neat compromise. They cut down the weight of the external skeleton to a minimum and, while they lose its protection, they still retain the great advantage of the additional strength. The result is tremendous speed of movement. But the insect can attain no great size, because of a very primitive oxygen supply system-just a number of tubes or traches going into the body from the outside air.

So nature discovered that if she wanted size—and apparently she too is mibude with this "bigger and better" idea—she had to have an internal skele-ton and a device for guaranteeing an adequate supply of oxygen, such as in the case of the shark. As a matter of fact, the shark is one of our very oldest associes.

But here, as elsewhere, the solution of one problem only led to another. All animal life up to this present had probably been in the water, but there was a lot of dry land and plenty of plant life on itwhy not invade? Only how? Once again that miserable question of oxygen supply held up the whole course of evolution. So nature handed this problem of an air-breathing land animal over to her research staff. Many and interesting were the early models. We have fishes which will drown in water, such as the Siamese fighting fish—it breathes air. Other fishes can leave the water and climb trees by means of their stiff fins. They take a deep breath, so to speak, in the water, close up the gills and hold it for ten minutes while on the land. Then we have a lung fish which can breathe in air when its pool dries up in the summer, but which much prefers water. We even have certain land animals some salamanders-without lungs. They just gulp air into the throat and from there the oxygen diffuses into the blood stream.

NATURE'S ultimate answer was, of course, the lung. Originally this was probably the air bladder with which many fishes are cuipped and whose duty it is to regulate the creature's buoyancy in water. He wishes to come up he inflates the bladder, and vice versalization with the course of primitive lung fishes got the knack of guiping air into this bladder from the atmosphere. Then the oxygen diffused through the thin walle into the blood

stream and we had our first air-breathing

We have come a long way from this primitive apparatus, however. The efficiency of your lung depends on the area of contact over which blood and air can come close enough to insure diffusion. The greater the area the more oxygen can pass into the blood stream. It is self evident that you would greatly increase the internal surface area of a simple bladder-say, a football-if you jammed it full of wrinkled tissue paper. The more you crinkled the paper and the more you crowded it in the more surface of contact there would be-always supposing that you have enough room left for very tiny blood vessels and air tubes to traverse the whole mass of paper. This was nature's trick to improve the lung Whereas the outside surface of your lungs is 16 square feet, so expert was nature at this crinkling process that the actual internal surface of contact is about 170,000 square feet, or over 10,000 times as great. So well has nature supplied you, that large areas of your lungs are relatively inactive. You can, in case of accident or tuberculosis, get along very nicely on one lung, or even part of a lung-provided you don't want to play football and race the engine.

So nature developed the lung and got an animal which could live on dry land. For the first hundred million years he put in the early part of his life in the water, as does the present-day frog. Then the race of true reptiles came along, laying their eggs on land, and so the true land-living species developed. But, before developing these land animals, nature found herself up against another engineering problem-that of locomotion. How were these animals to move? Evolved, as they were, from fishes, nature did not have much to go on, for a fish is pretty helpless on dry land.

But never be it said that nature sidestepped a problem. She took the four man fins of the fish, two in front, two behind, and resolutely set out to develop legs. This idea seems very simple to us today, but the nearest approach nature had arrived at which could be adapted to land use was the single large foot, best seen in the case of the snill. This guarantees progress, but not much progresssent properties.

In fact, now that nature bad produced a land animal, capable of large size and fast movement, ahe did exactly what the human being always does in the enthurs am of youthful ignorance: she overdeveloped and overproduced. Dineasure reptiles—came from the factory weighing up to 40 tons (your largest elephant weighs only ten tons), some of the carnivorous varieties being the fiercest beasts of prey the world has ever seen. The reptiles—invaded the sea and produced literal sea serpents. They even

sprouted wings, a-là-bat, and gave us the largest, fastest, and fiercest natural inhabitants of the air yet to be seen.

nablatants of the air yet to be seen.
In fact, the reptiles run the world. For from two to three hundred million to the years this world wan't safe for even another reptile unless he could move very fast or was so huge and well protected them to be huge and well protected the safe of the property of t

For some reason or other, nature had also manufactured these repules with a minimum of brams. Even the largest of them had a brain no bigger than your fast. They must have been extremely stupid despite their size and fierceness Nature has since been producing models with more and more brain and more brain.

But the real weakness of these reptiles which probably led to extinction was the fact of their being cold-blooded animals. This carbon-burning engine which we call our body as exactly like your auto many respects: it won't, go if it's too cold and it atops if it heats up beyond a certain point. The cold-blooded animal is at the mercy of the temperature, As the thermometer approaches freezing he becomes aluggish, and at freezing weather the machine simply stops. The same applications of the same about the machine simply stops. The same applications of the same about the machine simply stops. The same applications of the same about the machine simply stops. The same applications of the same about the sam

So nature evolved another model, the so-called mammal. She gave him a coat of fur to keep out the cold-or heatthen arranged an internal combustion system which works always so that the engine is continually warmed up. Not only that, but, in every species of mammals, she established an automatic thermostat. The human engine works best at 98.6 degrees. Any variation by as much as one half of one degree is a signal of engine trouble and for the services of a mechanic-no disrespect intended to the doctor. Just to make a good tob of it, nature established the same mechanism in the newly evolving race of birds. Then she stood by to watch results.

The new machine proved its superiorly in decisive fashion. Very soon the mammals and birds ruled the roost just as ruthleasly as had the reptiles. Then nature repeated ber old mistake—bigger and better, but bigger at any cost. She developed mammals, such as the long extinct "thunder beast," Baluchithertium, of Asus, far larger than the largest elephant. And once again she wiped out the lot.

The trouble with these huge brutes was one of food supply. Every so often climatic changes occur which cause huge areas of the earth to become semi-desert in nature. If we had a severe drought in the western plains for five years, a mouse or a rabbit might survive; for after all, he only needs a leaf

or two and somewhere or other that scant food supply will exist; the rabbits also might die by the millions but enough of them would survive to perpetuate the species, once the hard times had passed; but an elephant needs a hale of hay per meal, and that is something totally different. When drought conditions arrive, the big anmals suffer most. And, if the climate changes, as it has in the glacial spechs when huge areas of the world were covered by ice, all animals are ilable to extinction that cannot adapt themselves to a cold climate or to a hot climate, when the ice fields extreat.

So nature produced her latest model, man. She had learned that even her highly elaborate heat-conditioned manmal had its weaknesses, but she had also found that one of its most advertised features, namely, its brain, seemed really to be of surval value. In modern man she staked nearly everything on brains; for, as a machine, he is a joke His naked skin gives absolutely no protection against the weather He can't run rapidly; a tiger can eatch him in a twinkle And by himself he can't fight; any carnivorous beast his own weight can serve him up as preakfast to the cubs.

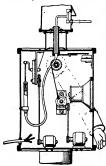
Though early man was much tougher than modern man, his best hope was his wits. Cornered, he sezzed a stick, and found his first club. One day he threw the stick and invented the spear. When the glaciers crept down he wrapped himself in a buffalo skin and discovered clothes. Somewhere he stumbled across fire. With skins, fire, and some sort of shelter he could let the blizzards blizzard if he didn't starve to death. But he didn't. He got the run of the seasons and learned to store food when the hunting was good against the lean winter period

THIS last child of nature became literally a brain child. It has long been a commonplace of parental experience that bright children may need a little discipline, and it seems to many of us that nature is now reaching for the slipper. Her grievances are many but may be summed up in one major charge: man is using his brains to eliminate the fit and to perpetuate the unfit. To qualify as cannon fodder in this 20th Century you must be a physically perfect specimen; while the others live on. Also, we have learned tricks which give us our present differential birth rate, a system which restricts birth in the upper classes, and this may easily yield us a "moronoc-

Any attempt to peer into the next million years merely impresses us with our own ignorance. We can say only that nature, after spending vast periods of time in developing a perfect machine witness the cat—seems to have made a departure in the case of man. He is a mechanical misft.

Automaton Salesmen

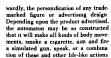
A UTOMATONS have been constructed by many engineers, in bodies that mimic those of human beings, but these have usually been for exhibition purposes and have been complex mechanisms of wires, photo-electric cells, and other special devices such as numerous push buttons, switches, and



Mechanism of one of the earlier mechanical men, the basic features being typical of many of the designs

relays. Decidedly, they have not been of the type that an advertising department would purchase in quantities for merchandising demonstrations. Automatons to promote sales are, however, now available from a recently formed corporation. They are covered by patents.

Mechanical Man, Inc., will make a figure to advertise any product by attracting the fascinated interest of the multitudes and thereby impressing upon them the particular trade name. More important, the figure may be made, out-



The ingenuity and versatility displayed in the design of the mechanism for these attention-compelling "sales





Top of column: Three small manikins which have een used to advantage in showing styles. Above: A bowing figure made of oil tins and an oil drum, used to greet patrons of garages service stations. At left: One of the cleverest figures so far made. The four-foot hunter holds his gun at rest, his head up and forward. Then, as the pheasant rises, he turns and tilts his head forward, sims and "fires" the gun, and a red light flashes





The penguin (top) puffs contentedly on a lighted cigarette, winks, and moves flippers and head. The girl drum major spins her batons and executes graceful movements

men" is their chief point of interest for the technical man. Their simplicity is, furthermore, most surprising. In all cases—whether the figure be small or large—all the action is powered by a fractional horsepower electric motor. Reciprocating movement of parts of the body is accomplished by rod linkages between disks driven by worm gears or pulleys. Adaptations of this simple principle give the designers an endless variety of possible combinations. A simple pump with a crank-operated pison supplies the suction, through a small tube, for puffing a cigarette.





A MONTHLY DIGEST

Conducted by F. D. Mc HUGH

ANTHRACITE ASH IMPROVES SOIL

PENNSYLVANIA anthracite ash has long been used to improve soils, but exact scientific data on such utilization were made available for the first time only recently compiling results of experiments conducted at the Mellon Institute of Industrial to Authority of Industrial to king Industrial to Industrial Tolking Ind

"Since anthractic sales are of a nuneral nature," the booklet points out, "their beneficial effect is permanent. In this respect they are superior to humins or other organic materials which tend to disappear from the soil in several years' time. A still further advantage is that humis and soil-conditioning materials are expensive, while Pennsylvania anthractic sales are readily available.

Contributing Editor ALEXANDER KLEMIN

In charge, Daniel Guggenheim School of Aeronautics, New York University

in the anthracite heated home at no cost." Suggestions for the improvement of lawn or garden soils are given, both as to amounts or garden soils are given, both as to amounts and methods of application of the sash, with outlines of procedure for the more scientifically minded or professional gardener for conducting his own experiments. Descriptions of additional uses are also given, in cluding utilization as a summer mulch, for underdramage, for sail-iless culture, even for growing rhubarb in the basement during the writter months.

TELESCOPE MUSEUM

WHEN the Corning Glass Works cast the first of the 200-inch blanks for the gigantic telescope on Mount Palomar, California, some of the cores with which the inder side was to be honeycombed floated

out of place and made is necessary for a nov blank to be cass. Because this great disk was the first such enormous casting in glass in the world, a stream of visitors was contunally passing through the plant to see it, and it was finally decided to install this blank in a miseum of its own in the city of Comm. Accordingly, a structure resembing a ministure observatory has been built in the Comm. College of Sequence, and by the land of the comment of the control of the land of the control of the control of the through the control of the control of the through the control of the con

a permanent exhibit
So gganite is this "sky eye"—17 feet in
dometer and 20 tons in weight—that it was
found necessary to build a special carriage
for transporting it. An accompanying illustration shows the disk being transported
through the city of Corning to its permanent
museum. In this picture is clearly shown
the imporfect honeycomb of its bases.

WATER SOLUBLE RESIN

A SYNTHETIC resis which as mostible in organic solvents but soluble in water, acrds, alkales, and salt solutions has recently been announced. It is film forming when deposited from aquoous or water-soluble thickner; a solvent solution. The resin, Rhoter A.20, is recommended by the manufacturers as a water soluble thickner; a solvent resistant coating; a sunng, emulsifying, and dispersing agent, or a clear, colories film hase.

CANCER MAY BE CAUSED BY VIRUSES

CANCER, at least of certain types, is caused by filterable viruses, and thereby Joins a numerous and varied group of human fils including mullpox, influents, influents, and the state of t

Reynals of Yale University.
Fluids from malignant transplantable tu mors of chickens were whirled in the ultra-centriding, based through fine-pored filters, and otherwise treated after the manner of virus-containing fluids in knowa animal and plant diseases. Materials obtained from these canocreduid filtrates, injected into the tissues of healthy chickens, produced typical canoerous growths.



Moving the giant telescope mirror blank to its museum



The 155mm field gun being towed by a track-laying truck

is heavy traffic

In the researches reported by Dr. Duran-Reyala, chicks responded to doses of a tumor wins by developing fatal hemorrhages and degeneration of tissues, without the development of tumors. However, extracts obtained from such chicks produced the characteristic growths when injected into healthy adult fowls—Science Service.

LONGEST-RANGE

FIELD GUN

THE United States now has a field gun any other standard field gun has ever hene fired. Of 155mm caliber, it sends a projectile a distance of 25,000 yards or, roughly, 14 miles, and blasts a hole in ordinary ground 16 feet deep. It has been named the 155mm gun, MI

Development of this gun grew out of a need seen in the World War, particularly at about the time of the first battle of the Marne The noted French artilleryman, General Herr, wrote of the difficulties the French had in retreating under the heavy fire of German guns with no guns which could answer in kind They needed artillery of very long range which could remain far behind the lines and yet paralyze the enemy and harm their morale This would be done by insistent shelling of the main roads of enemy approach, important stations, ammu nition depots, and centers of distribution, and by making their headquarters untenable and demolishing points of observation. Further, these guns were found necessary for bombarding the enemy's roads of retreat, their reserve stations, and supply dumps of all kinds This kind of fire was called inter-

Hence, there was a demand by the Caliber Board of the United States Army for a gun of about caliber 155mm, with a vertical are of fire from 0 degrees to plus 65 degrees; a horizontal are of fire of 360 degrees; a projectile weighing not over 100 pounds; an maximum speed of 12 miles per hour; and



a width and maneuverability which would permut its use on highways on which there ington Many miles of

The 155mm gan has met most of these requirements In weight exceeds the weight limit by 28 percent, as it is slightly over 55 tons 11s overall width is about 99 inches which is somewhat too wide for rapid movement in two-way traffic. On anything had an width provide a severe handicap, Despite these factors, it is an extremely efficient weapon. In action, it will not be called upon to make long forced marches but will be used as our principal instrument for resching the long-range targets mentioned above. It will, of course, he as interest on railways mounts

This new gun is mounted on a six wheel bogic with rubber tires and in the firing position will be lowered to a firm position made by spreading the outrigger spades.

JUMBO CANAL-WALL

TRIMMER

THE fourth and last section of the great
"Yakima Project" is now far advanced—a system of canals, tunnels, flumes,
and siphons which will eventually irrigate

72,000 acres of farm land in central Washington Many miles of this project will be canals of an open "V" shape with concrete walls and beds. To expedite the concreting job, the sides and hed were trammed by a unique traveling machine developed in the shops of the H. J. Adler Construction Company.

This new trimmer rides on a single rail ach canal bank. It is powered by three Ford motors—one on each bank, and the third for the belt conveyor which is loaded by a centrally located bucket elevator. The entire trimmer advances at the rate of a

foot and a half a munute. The sides of the "V" are two 17-foot rollers, studded with hundreds of small proceing teeth or pars. As these rollers, which are made of 12-inch heavy-duty pipe, which are made of 12-inch heavy-duty pipe, are moved along the slopes of the canal, the spirally-set teeth engage every unch of the usrface and sheart it smoothly. The shearing is so complete that no overdaging or any complete control of the control of

EXPLOSIVES

IN the past 12 years, American and Canadian railroads have transported millions of tons of high explosives without death or injury to anyone.

WASTE

AT one of the symposis of the recent metling of the American Chemical Society were discussed some of the more important of the large number of instances where important outstrain or task wastes have been converted through research into raw materials for the manufacture of commercial products. It was stressed that differentiation must be made between by-products in the usual seense and materials which are true waster— —mot only useless but often Involving es-

pense for their satisfactory disposition.

Under this latter classification may be included the manufacture of sulfaric acid and recovery of elemental sulfar from smelter gases, the production of sulfuric



Traveling canal-wall trimmer that rides on rails

acid from the hydrogen sulfide in petroleum still gases, and the recovery of hy-product sulfur from the hydrogen sulfide in illuminating gas. Sulfite waste liquor has become the source of vanillin and a number of other products.

Waste casein finds its way into resins and adheaives; the fermentation readices in the alcohol industry have been converted into cattle foods and the carbon dioxide into dry ice. Potash is recovered from the dusts of the cement industry, and building blocks have been made from the fit sah.

In a sense, the long list of solvents now recovered from gested erived from petroleum represents success in the use of othernies water materials. The same may be said of cements made from blast furnace alag, and synthetic methanol utilizes carbon monoxide present as an interfering substance in gases used in the fixation of nitrogent branch from the same to the same perior of the same of the same of the same type of the same of the same of the same type of material.

LINENS

THE Pullman Company is sometimes called the world's greatest housekeeper. In one year it purchased 220,528 sheets, 157,780 pillow cases, 20,253 tidies, 455,829 hand towels, 24,318 headrest covers, 13,692 napkins, and 3260 table cloths.

CHLORINATED RUBBER

F further proof is needed that American engineers and chemists are equal to or better than European technicians, it may be found in a recent issue of Chemical & Metallurgreal Engineering, James A Lee, writing in that magazine, states that in the few years succe securing the rights to produce chloritated rubber in this country, Hercules Powder Company chemists and engineers have improved the original characteristics and have been exporting chlorinated rubber to the themselves of Europe

VINYON, IMPORTANT SYNTHETIC FIBER

ANOTHER synthetic resin fiber, that can A be turned into lustrons silk-rivaling hosiery, has just been announced. Known as polyvinyl acetal resin, the new fibers are further cause for headsches among the Japanese for they are synthetic, made-in-America rivals for Japanis natural silk. Silk is the largest single export of Nippon to Uncle Sam.

A research team of Carbide and Carbon Chemicals Corporation, including Harold F. Rohertson, Edward W. Rugeley, Theophilus A. Field, Jr., John F. Conlon, C. O. Young, and S. D. Douglas, has been busilty piling up patent after patent on this achievement.

Polyvioyl acetal reain can be produced in fiber as fine as matural silk, virtually as strong, more clastic, waterproof, and fireproof. The basic materials of the tweest fibers are salt, coal, lime, and air. Out of these cheep and plentiful raw materials are made high molecular weight (7000 to 13,000) water-plare rains. The actual production consists of polymerizing vinyl halides with vinyl esters. Among the suggested uses of the new fibers, heides the hosicy field, are: waterproof clothing, bathing suits, fireproof awning which are self-like in appearance, fabing lines, fabing nets and selnes, acid and talki-resistant clothing, electrical mulation, and curtans for shower baths. The new fiber material, to be known as Vinyon, is not yet in commercial production for houser, in 8 rd properties, it is comparable houser, in 8 rd properties, it is comparable although the latter is made by a different chemical method—Science Series.

BIGGEST BUTTER

MAKER

THE largest churn in the country has just been built by the Jensen Creamery Machinery Company, Oakland, California, and installed in the Challenge Cream and Butter Association plant in that oty. It is constructed from two sand-cast aluminum shells which, together, weigh 1500 pounds in testa, this unit has churned 660 gallons of cream into 2580 pounds of butter



Batches of 2580 pounds of butter are made in this aluminum churn

in 30 to 45 minutes Because of the cubical design, the churn is reported to he capable of churning hutter in 50 percent less time than the conventional roll type units.

The huge aluminum castings which make up the body of this new dairy machine were cast at the Los Angeles foundry of the Aluminum Company of America, and are among the largest aluminum castings ever made. The patterns were so large that special doors had to he built in order to move them out of the pattern shop into the foundry for casting. Aluminum was used in the construction of this churn in order to obtain the advantages of the metal's lightness and non-contaminating properties.

NEW REFRACTOMETER

A SIMPLE instrument for measuring the representation of the representation of the General Electric Research Laborator, Though smaller and much less costly than previous instruments, the new refractometer is accurate to two desimal places. The principal parts of the device are a telescope, monated like a microscope, and a pollshed metal prism. One surface of the latter is vertical



Refractometer and its telescope

and another is at an angle of 45 degrees from the axis of the telescope.

As the angle of till is fixed at 45 degrees by the prism, only the thickness of the glass and the amount of displacement of an object viewed through it need to be measured The thickness is measured by placing the sample against the vertical face and taking comparator readings.

Attached to the fulled surface of the prison is a pace of drawing paper on which a large dot has been made with black int. Displace ment is measured by adjusting the hase until the cross-hair of the telescope is annually a servent directly, and then through the test glass. The difference is the optical displacement. With this datum, the index of refraction can be determined by silde rule and reference to table.

For the study of thick glass, the use of a sodium lamp as an illuminant has been found advantageous.

PHOSPHATASE TEST

MADE ELECTRICALLY

ANOTHER atep in making milk safe for public consumption is taken by the Luximeter, a new instrument developed by the General Electric Company to check the degree of peateurization of milk by the phosphatase test.

A chemical test for determining the de-



Milk undergoing phosphatase test



A truck is used for transporting the radio-controlled target plane to and from the anti-sireraft range

gree of pasteurization has been used for the last few years with great success in the Scandinavian countries, and the New York State Department of Public Health has been among the first in this country to experiment with this method of making the phosphatase test. General Electric has been

working in close collaboration with the New York State Department of Public Health for the last year and much valuable data and suggestions have resulted from the efforts

of the Health Department.

The G-E Luximeter, while designed primarily for use in measuring the transmission of the blue solution obtained in the phosphatase test for milk, has many other possible applications. One use in particular to which it may be resdily applied is that of making a turbidity test in water supplies. Satisfactory turbidity measurements have been made over the range of 100 to 3500 parts per million on the silica scale.

The new instrument consists of a light source, a light-sensitive cell, and an indicating instrument, all in one compact unit. The light source is regulated by a rheostat and is directed through a glass tube containing the solution to be measured. The light so transmitted falls on the sensitive surface of the cell where the values are read directly in percentages on a micro-ammeter

Requiring only a six-volt, half-ampere power supply, the Luximeter may be attached to a storage or dry battery, or voltage regulating transformer. The new instrument weighs only two pounds. It may be carried about by milk inspectors on their tours of dairies or used by large dairy owners in testing their pasteurization.

PHOTS

BY the end of 1941, Robert H. Hinckley, Chairman of the Civil Aeronautics Authority, predicts that the United States will have a total of 70,000 licensed pilots.

RADIO CONTROLLED

TARGET AIRPLANE

POR training infantry and field and coast artillery in anti-aircraft gunnery, targets re frequently towed behind an airplane which flies at a relatively low height. These targets are of the sleeve type, resembling the wind socks seen at most airports.

Towing sleeve type targets has many dis-

the small air-cooled engine of the target plane is started and adjusted to the required revolutions per minute. A catapult shoots the sirplane into the air, and flight is maintained by two small propellers driven by the single engine. These propellers rotate in opposite directions so that torque and slipstream effects are eliminated. When, the aerial target has completed its mission and given the ground personnel sufficient practice for the day, the operator directs the little craft to a landing area. He then presses a button; immediately the motor stops and a parachute springs from the airplane. The target floats gently to the ground and is soon ready for another tour of duty.

One of the advantages realized, in addition to the disadvantages eliminated, is the small cost of construction and the ease of maintenance and repair. Even if struck in a vital spot, the target airplane can be readily put back into commission. Again, the target airplane can be operated in a minimum of space, at a place convenient



Target plane ready for launching from its catapult. A two-cylinder engine drives the twin propellers

for any branch of the service. Previously, anti-aircraft practice could be undertaken only in the vicinity of a large airdrome .-

advantages. The targets cannot be maneuvered sufficiently, and they do not simulate the outline of an airplane The pilot of the towing airplane may be struck by a stray bullet-although such a mishap has not occurred to date. Further, the rifle or machine gun personnel on the ground have no way of telling whether their fire would have reached a vital spot of the airplane.

All these disadvantages will be eliminated, and many new advantages will be secured, by the use of a small radio controlled airplane which is in process of test by engineers of the Army Air Corps at t Field, Dayton, with Captain George V. Holloman directing the experiments.

The little airplane is only about one third the size of a normal combat airplane and has a 12-foot wing spread. It is flown at reduced speeds and has a service ceiling of about 5000 feet. The target airplane is maneuvered solely by a radio transmitter controlled by an officer standing in a safe ention on the ground. By means of a small hand-held instrument, similar to the dial of a telephone, the ground officer can cause the target plane to turn, bank, dive, or zoom. giving realistic representation of a maneuvering aircraft.

When all is in readiness for the take-off,

FOUR BLADED

PROPELLER

THERE seems to be no difficulty in increasing airplane engine power almo indefinitely. At least the power of aircraft



Fettr blades for powerful engines

engines seems to go up a hundred horse-power or even more per annum, and such progress has been continuous for at least ten years. The increased engine powers in-troduce a serious difficulty, however, in the matter of the propeller.

To absorb the power of, say, a 2000 horsepower engine, in a relatively small airplane, the diameter of the propeller becomes in-ordinately large. This means a long, heavy, ordinately large. This means a long, heavy, and clumsy landing gear, which is a serious disadvantage. Also, the speed of the enode of the propeller hlades becomes so high as to approach the speed of sound—with consequent loss of thrust and efficiency. As a result of these facts, Curtiss produced the speed of the spe

peller engineers have now replaced the three-hladed airscrew by a four-hladed one. Tests have indicated that this new trend in propeller design is quite satisfactory, though even with the four blades there is some sacrifice in efficiency compared with airdiameter.

The airplane shown in the photograph is the Curtiss P-36A pursuit, which is highly popular with Army Air Corps pilots. The blades of the airscrew are of thin aluminum, and are electrically controlled. The pilot can select the pitch, and then the airscrew can be used as a constant speed propeller.
When the engine stops it is possible to feather the blades fully; that is, to set them completely on edge to the airstream. This combination of characteristics is very useful for reasons which we have discussed in

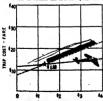
At high altitude the absorption of power of a supercharged engine is still more diffi cult. Some engineers even believe that in addition to pitch control, and four blades, airscrews may need a change-speed gear or even extensible diameter. In fact, one company is already working on an extensible diameter propeller.—A. K.

ECONOMY OF AIR

TRAVEL

THE following figures have been sub-mitted to us by an airline company, whose name we do not mention for ohvious reasons. Even though they come from an interested source, the figures and arguments are so logical and so trustworthy as to deserve full credence.

It is true that air travel fares were once considerably higher than those for other types of transportation. And although rates for air travel within the last few years have



TRANSLESS SALARY-BOLLARS PER HOUR the enemy of serial trun-

been substantially reduced, air travel : still in many cases a higher fare form of transportation. Yet the differential between air and railway travel is not great, and pracair and railway travel is not great, and prac-tically disappears when other expenses are taken into consideration. Thus a round trip hy air from Atlanta to New York costs only \$81.84 and takes only 12 hours. Meals are free and there is no tipping. This same round-trip by rail costs \$58.75 for fare alone. plus an average expense of \$11 for meals and tips en route. And the rail trip takes 45 hours

When salaries of husiness executives are taken into account on a conservative basis, air travel actually becomes cheaper. For a trip of 200 miles, when salaries per hour and time saved are taken into account, the husiness man saves money when his salary reaches the figure of only \$1.18 per hour .-

OIL CONDITIONER

UBRICATING oil in motor cars accumulates impurities such as water, acid. dust, carbon, and metal particles. The heat of the engine plus the oxygen in the air form engine-clogging products generally re-ferred to as "varmah." These resins and tars affect the engine's performance, and in some cases may "freeze" new motors Frequent cleaning of the oil by passing it



Thoroughly clean oil, free from all dirt, impurities, and acid, is delivered to the motorist from this oil conditioner. Dirty oil from the crankcase is pumped into the device, where it filters through a cartridge and is cleaned

through a new device called the Filtermaster will stop the trouble caused by such im-

The Filtermaster, which is made by Clea Oils Corporation, is a simple tank-like affair into which the oil is pumped from a motor-car engine. The equipment does not do an actual job of reclaiming in the or-dinary sense, but does clean and wash the oil of all impurities. It uses a special, re-placeable filter cartridge which absorbs the impurities, and a neutralizing alkali to cou teract the acidity of the oil as it passes

The machine ordinarily runs an average of 25 gallons at a time, so that the car owner does not actually have returned to him the identical oil which was pumped from his



The oil conditioner

car. The theory of operation is that a garage owner would either simply swap clean oil for old or make a standing contract with steady customers to keep clean oil in their motors for a specified period at a specified

PAPER COATING FROM CORN

AVAILABLE as a by-product of corn processing, Zein, an industrial protein, gives promise of outstanding usefulness in the paper coating field As a decorative coating for magazine covers, labels, and similar uses, it gives a pleasing surface without the high gloss of some other coating materials. It can also be formulated with a high gloss and is particularly notable for

high gloss and is particularly notable for resistance to scutfing. Commercially produced as a fine powder of slightly yellowish color. Zelin contains not over 2 percent non-protein solids. The potential yield is approximately one pound per bushel of corn.

HEAVY

A CUBIC inch of matter from A a recently discovered white dwarf star, named Wolf 457, would weigh 9000 tons. This is just under the weight of a -the weight of one of our latest Navy cruisers. A partiele of this could not he supported hy any known matter on earth, for it would "sink" through even our strongest metal.

INFRA-RED RAVE SPEED SEED

GERMINATION

NFRA-RED rays have been successfully used to increase seed germination by as much as 50 percent. This is the report that comes from the Leray Corporation, makers of the infra-red lamp which was described in our January, 1939, issue, based upon tests made some time ago by the Sanders-Durling Entomological Service of New



York. These tests indicated a very noticesalle stimulation as well as an increase in germination.

In these tests, seeds were subjected to the infra-red rays from the Leray lamp. This lamp is attached to any 110-volt electrical circuit, and is moved slowly and carefully at a set distance above the surface of the seeds. Ten seconds has been found to the the most effective time for keeping the

lamp in any one position.

The success of these tests indicate possibilities for improving gardens by insuring better germination.

CEMS

THE Smithsonian has just had added to its collection the largest topaz crystal ever known. This crystal, totaling 350,000 carats, compared with the ordinary gem topax of four or five carats, was found in Minas Geraes Province of Brazil.

DIKETENE AND THIODIGLYCOL

DIKETENE, to which the structure of varyl beta acetoloctone has been as signed, was described at a recent meeting of the American Chemical Society, It is a new radiatrial chemical which is now wailsable in commercial quantities. Its industrial importance hear in the valuable products which may be synthesized from it because of its exceptional reactivity.

Of current interest is thiodiglycol, also discussed at the meeting. This chemical is useful chiefly as a starting material for the manufacture of mustard gas. A new method of synthesis from ethylene oxide and hydrogen suifide was described, which is much less expensive than former methods.

UNBREAKABLE WATCH CRYSTALS MELTED INTO PLACE

UNBREAKABLE watch crystals, in use for many years, have had a disadvantage in their inability to exclude dust from the face of the watch since their flexibility

Melting an unbreakable watch crystal into place. Inset shows a crystal, mounted in position, from which part of the surplus plastic material has been trimmed

causes them to bulge and leave open cracks at the edges. A new method of mounting such crystals on watches, developed by Dutcher Bros., Inc., gives a perfect seal at the edges.

This corporation puts the watch into a machine especially devised for the purpose, places an oversized crysial on the watch, and them melis it into place under slight pressure at a temperature of 225 degrees. Fahrenheit. No cement is used, but the melting at the periphery of the crystal seals at to the rough deges of the beet. The surplus plastic material from the edge of the crystal is their tummed off.

FLUID ANALYSIS

BY LIGHT

A NALYSIS of colorless fluids and some colored fluids which appear colorless is a simple and quick process with the new colored fluids which appear colorless. It is a color to the color of t

The Model 10 R-S-photometer utilizes the proved basic principles of apectrophotometry. A control with a linear scale, calibrated from 350 to 1000 millimicrons, from the near ultra-violet far into infra-red, permits selection of any 30-millimicron band to fall on a slit opening into the test chamber. Light from this selected region of the spectrum then passes through the sample

More or less absorption occurs, depending on the nature of the fluid being exsmined. The unabsorbed light as collected in a photocell and quantitatively determined to better than 0.5 percent. By substituting a standard solution in the same light path, the ratio of the light Intensity at the selected wave hand is inducted directly as percent transmittance by any Model 3 Coleman. Electrometer. These results are indepencient of line voltage fluctuations and do not depend on colored filters. These data are precise expressions of fundamental units of color chemistry—percent of transmittance at known wavelengths of viable or invisible light.

VARIABLE POWER

TELESCOPES

GHARP images in steps of five powers, and of the powers are claimed for no 80 brovens are claimed for new telescopes recently an annuared by Wolfersak Optical Company, No one telescope gives this full range though there are as many as its ranges in some of the new telescopes. Under the trade ame of Vari-Power, these telescopes have hurried focusing ring; non-loosening, non-wolfle joints that are dust-proof at moisture-proof; and chrome-plated rust-proof tubes.

PENCILS

NEARLY four million lead pencils and 2600 gallons of ink per year are used by the employees of the steel industry.

BELL-RINGING RADIO

DEVICE

A NEW bell-ranging device, which permits emergency radio call to be put through as easily as telephone calls, has been developed in the Forest service Radio Laboratory at Portland, Oregon. This standby unit has been developed for the new Type T ultra-ligh-frequency radio set, 30,000 to 40,000 kinceyles. Any Forest Service ultra-high-frequency radio set, however even the lightness eight-pound portable even the lightness eight-pound portable—



Above: Interior of the bell-ringing device developed for Forest Service radio equipment. Below: Ringer connected in standard setum



can call a lookout or other station equipped with this bell-ringing device. Planned primarily for use at fire lookout Business by"-a noise especially annoying during telephone conversations.

by Westinghouse

begins with BUYING



· A manufacturer must buy before he can sell. He must buy the raw stuff that goes to make the finished product; he must buy machinery and the plants to house it, and must hire the men without whom the finest equipment in the world would be just so much worthless scrap.

· In our particular case, being a large manufacturer, we are first of all an enormous buyer. If all of the copper wire we buy in a single good year were converted into sixteenthinch wire, the strand would stretch over 209,000 miles-enough to wind eight times around the Earth. And the insulating yarn we buy could be looped 36 times from Earth to Moon.

· We use enough steel and iron each good year to build two railroad tracks 2,290 miles long-or a couple of Oakland Bay Bridges.

· We buy a lot of gas, oil, hydrogen, nitrogen and oxygen; we are a huge consumer of gold, silver, mercury and tungsten. You won't find the kind of sapphires we use for bearings in a jewelry store-nor would you find a jewelry store in the world that could supply the 20,000,000 jewels we need each year. We even buy dismonds and use them as dies for drawing very fine wire. Though most of our purchases run into tremendous quantities, one of them, last year, amounted to just one ten-thousandths of a gram. That was radium, and it cost \$300.

· Every one of the forty-eight states and Alaska are important suppliers of ours. Twenty foreign countries contribute materials not produced in America. Almost literally, every industry and every farm produces something that we use.

· "What in the world can a farm grow for Westinghouse?", you ask. Just to name a few things - oat hulls. molasses, grain and sugar cane for alcohol, dextrine from corn, flour and straw for making foundry cores, lard, sugar, lumber and tapioca; also leather, wool, cotton and meat products. It all adds up to this. Each vearwe buymorethan \$100,000,000 worth of the products of industry and farmers. Some of our people have estimated that these purchases give work to about 36,000 persons annually. This is in addition to our own 43,000 employees who fabricate these materials into a vast number of machines and appliances which increase the permanent wealth of America.

· Who gets this wealth? Why, the industries and farmers who sold the materials to us, of course. It's really nothing but an elaborate process of swapping. We swap what we make for the materials needed to make our products:

· That's why we cannot consider ourselves as a separate industry. Along with thousands of others, we are merely an essential cog in the tremendous process which has created American prosperity and the American way of living.

towers, ranger and dispatcher stations, this device will eliminate the constant noise from loudspeakers when operators are "standing

Lookouts and other forest officers will no longer need to stay close by their radio sets waiting for calls, as the device may be adjusted to carry signals to men working outside their stations. Lookout men can be aroused from sleep by the ringing bell if a night-look for fires in their territory is required. A series of code-rings is possible when several stations are included in any one Forest Service network.

PORTABLE METAL FIRE ESCAPE

NEW fire escape which combines the strength of a permanent fire escape with the portability and case of handling of a rope ladder is shown in one of our illustrations. A product of Engineering



Development Company, this unit may be anchored on any window sill without diffi-culty, and then dropped to the ground as one would drop an ordinary rope ladder. In the 16-foot length for a two-story buildand the lottor length for a two-story building, the ladder weighs 15 pounds, while in the three-story length—24 feet—the weight is 20 pounds. The load capacity is 1800 pounds, and each rung, which is built in the form of a stirrup, has a footing of 4 by 91/2 inches.

FIRST YEAR OF THE CIVIL AERONAUTICS AUTHORITY

T was quite appropriate that at the com-pletion of the first year's work of the Civil Aeronautics Authority, Chairman Robert H. Hinekley should make public a statement as to its own activities and those of civil aviation as a whole, which, from every point of view, have been highly againfactory.

In June, 164,578 passengers were carried, or 64 percent more than in the corresponding month of 1938. During the first six months of 1939, 1627 airplance were pro-duced, while in the same period for 1938

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only 850 civil aircraft were constructed. Today 26,144 pilots hold certificates, or 6000 more than a year ago. There are 11,160 certificated airplanes or 1400 more than a year ago. Even without the C.A.A. pilot training there should be 36,000 certificated pilots by the end of 1940, and 43,000 by the end of 1941.

Federal airways have been increased to a total of 25,000 miles, with improvements in aids to navigation more than keeping

The C.A.A. flight training program will give us 10,000 student pilots next year.

The Washington airport at Gravelly

Point is beginning to take shape, with work proceeding rapidly under the supervision of the Corps of Engineers of the United States Army.

The existing system of scheduled airmail carriers is now legally a public utility. Cer-tificates have been issued which make the existing airlines secure in their positions and free to plan for further progress.

The safety record of the airlines has been remarkably good. They flew 72,900,000 miles per pilot fatality; 51,700,000 passenger miles per passenger fatality; and 24,300,000 miles per fatal accident. These records are nearly three times better than the same records for the year 1938.

Technical developments have been equally assisfactory. Ultra-high frequency radio ranges operating at 63 and 125 megacycles at Indianapolis and Pittsburgh have been proved to be free of static whether from natural or artificial causes. This freedom from static, particularly in bad weather, is one of the most important elements in air transport radio communication and safety. Contracts have been let for three units of a new and approved type of ground direction finder. The blind landing system nearing completion at Indianapolis is one of the most comprehensive yet devised.

The Safety Board has developed its methods of accident investigation, with hearings conducted at or near the scene of the accident within a remarkably short time thereafter. The publication of reports after such investigations has given aircraft constructors and operators much valuable information .- A. K.

CHEAPER COPPER

PROTECTION ON

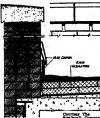
FIBER BASE

C OPPER has been valued as a protective metal in building construction for many centuries. However, its high cost milimany centuries, rowever, its night cost min-tates against its use in many places where it would do a superior job of protecting against leakage or dampness. At least two companies—The Sisalkraft Company and the Angier Corporation-have provided an inexpensive product for use in all types of flashings, which combines the protective value of a very thin copper sheet with the strength and body of an adherent impresnated fiber.

Both of these companies use very thin sheets of pure copper completely free from pin holes, produced by electrical deposition

of the copper on lead drums.

In the case of the Sissikraft product, this thin sheet is bonded under heat and pressure to their own tough product celled Sissikraft. The resulting sheet, which may be made in different thekenesses for different sapislar.



How thin sheet copper, bonded to a fiber hase, is used to waterproof a parapet and damp-proof the insulation under built-up roofs

tions, is flexible, will not kink or crack, can be cut to fit with ordinary shears, and is casily bent to place by hand. The Angier Corporation's product, called

The Angier Corporation's product, called Copperskin, is backed up with tough and durable paper to provide the advantages of regular 16-unce copper at approximately one fifth the cost. The backing material is called Brownskin, is resilient, and can stretch or shrink with the expansion and contraction of the copper due to temperature changes.

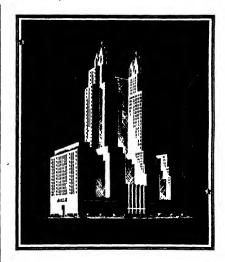
FROZEN SOLAR ENERGY

FLORIDA sunshine shed its glow at the New York World's Fair one day, playing a rôle in ceremonies at the Florida State Exhibit Building. Flown from Jacksonville in mert form, the sunshine had been abworhed by luminescent powder and "canned" by being frozen in liquid air.

The feat of rendering solar energy inert, then transporting it nearly 1000 miles and releasing it, is believed to have been accom-



Mr. Hibben measuring a quantity of pewder sich as was used for demandration "connect" small shi



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plished successfully for the first time. It was directed by Samuel G. Hibben, lighting engineer for the the Lamp Division of the Westinghouse Electric & Manufacturing Company.

In absorbing light energy, scientists beheve, the luminescent powder actually undergoes a temporary change in physical structure. The theory is that the outermost orbits of electrons, which make up the molecules and atoms of the powder, are distorted or literally moved from one energy level to another when excited by impinging light, actually imprisoning some of the light,

Then, just as a piece of sponge rubber aprings back to its original shape on being released from the hand, so do the electrons tend to return to their normal positions, and in so doing, give out the light energy they have imprisoned.

ELECTROMETRIC pH STANDARDS

TIME-SAVING capsules of chemicals in powder form are now available for use as reference standards for checking electromeine pH apparatus. The "Hydrion" Buffer Standards, as they are called, when dissolved in the proper amount of distilled water, make solutions, the pH of which have been electrometrically checked by the menufacturer Five different standards are offered, ranging from 3.0 to 9.2 in pH value.

STORYTONE

AN electrical musical instrument that cap-tures all the richness of tone, volume, and color of the grand piano and is housed in a cabinet no larger than a spinet, has been developed by RCA engineers in col-laboration with craftsmen of the Story & Clark Piano Company The new instrument will be marketed through Story & Clark dealers under the name Storytone "Voiced by RCA Victor."

Providing the music of the piano, the radio, and the phonograph, the Storytone utilizes specially designed electrical amplifying and speaker equipment to reproduce the full range of tones with sparkling clarity and brilliance. The volume is easily con trolled by a single knob located at the end of the keyboard panel. The range is so flexible that a single turn of the knob produces the softest whisper of a note or brings forth the full tonal blend of a powerful crescendo

When the volume control is adjusted to conventional piano range, the Storytone rivals the largest concert grand piano, and when the amplifier is turned low or completely off, a pleasing harpsichord effect is produced. In addition to the customary "damper" and "soft" pedals, the instrument is equipped with a "swell" foot pedal with which organ effects may be produced through regulation of the amplifier volume.



, Bench of the Storytone, opened

Used in conjunction with either a radio or phonograph, the Storytone reproduces radio programs or recorded music. A special piano bench has been designed which contains a radio and phonograph located separately in two sliding drawers placed directly beneath the seat. A simple plug-in connection per-



mits essy operation of either instrument. The

Storytone may also be played while the rsdie or phonograph are in operation.
Unaffected by either temperature or hu-

undity changes, the instrument's tone is developed electrically through a seven-tube amplifier of 20 watts output. Set in motion by the percussion of the striking hammers, the mechanical vibrations of the strings induce corresponding electrical vibrations in the coils of magnetic pickups. These electrical vibrations are then amplified by radio tubes and converted into audible musical tones by a powerful high-fidelity loudspeaker.

JUNIOR ARC WELDER

FOR garages, blacksmiths, construction engineers, machine shops, and others, a new 200 ampere arc-welding unit, either belted or direct-driven, has been developed by the Lancoln Electric Company A compact unit, with its own control board, this welding unit weighs approximately 320 Dounda

OLD BUILDINGS MADE FIRE RESISTANT

OUR out of every five deaths caused by tenement house fires-that annually take a toll of hundreds of lives in American tities-esn be prevented.

A four-year campaign by the New York building department to make Old Law tenements more fire-safe, has succeeded in reducing the number of deaths resulting from general conflagration in them from 38 in 1934 to 7 in 1938.

The campaign, backed by State legisla-tion, is an effort to make the average Old Law "tinder box" into a more fire resistive building by requiring that it be equipped with a fire-resistant cellar celling, fire-retarded stairwells, and modern stair-type fire

The total cost of all three improves according to general estimates, is about \$50 a family—inexpensive and permanent

life insurance for the families protected. Fire-retarded stair halls, the basis of the contribution to Suilding safety. It is an attempt to make the ordinary wood student plants and plaster stain-hall walls of the average

INDUSTRIAL and LARORATORY EQUIPMENT AT UNUSUAL VALUES



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tenement house more fire-resistant so that they can confine the fire to its place of origin instead of serving as a glast fine for the flames from first floor to roof.

Various methods of fire-restarding are today approved by the New York Building Department. The simplest method, how-look the service of the service of existing construction. Widely used in New York City, it employs granulated mineral wool, a fire-proof insterial with excellent heat-topoping properties that has been used heat-stopping properties that has been used for many years to insulate the roofs and side walls of building against heat and cold

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WHAT is believed to be the fastest camera in the world, shooting 120,000 pictures per second, does not employ glass-lenses. Instead, it has 1000 holes .01 of an inch in diameter, or approximately the size of a pin hole. The drum-like camera is used in the study of electrical arcs so that en-gineers may analyze the behavior of such arcs in circuit breakers and other electrical apparatus.

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of an inch on a side. While intended primarily for the study of electric arcs, other applications for this camera may be found.

THE CHEMICAL STRUCTURE OF VITAMIN K

CHEMISTS working independently at two different institutions, Harvard University and Saint Louis University, have determined the structure of vitamin K, the blood-elotting principle. The structural formula, according to the chemists, is 2-methyl-3-phytyl-1, 4-naphthoquinone.

The synthetic vitamin was checked by comparing spectra, color reactions, anti-hemorrhagic activity, and chemical prop-erties, with those of the natural vitamin obtained from alfalfa.

The synthesis is declared to be an efficient and practical one suitable for manufacturing purposes, and the pure vitamin is thus made available for use in medicine to prevent and control hemorrhages.

VERSATILE DEHYDRATOR

THE Henry Cartridge Dehydrator, originally designed for air conditioning and refrigeration, is finding increasing use where need exists for removal of moisture from chemicals in solution, and in air drying. The major features of this Henry dryer

are its patented dispersion tube and re-placeable dehydrant curtridge. The per-forated dispersion tube—exposing the en-tire volume of dehydrant to penetration by the fluid or air—extends along the center axis of the dehydrant column. This construction is claimed to reduce the press drop, prevent channeling and resultant loss of efficiency so often found in dryers of conventional design.

Refill cartridges make recharging of these Henry dryers exceptionally simple and easy. Cartridges are available charged with acti-





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"FLOATING" BRAKE

LINING

A SINGLE piece of "floating" lining is a novel feature of a new design brake adopted for the recently-announced Crosley This lining is not riveted, but "floats" freely between the brake shoes and the drum, thus affording braking action on both its surfaces instead of only one side as



The lining "floats"

in conventional brakes. An interesting feature of this hrake is the "creeping" or slowly rotating action of the lining, which distributes wear evenly over the entire lining surface, thereby greatly increasing its service life

Should it be necessary to replace the liming after prolonged service, it is necessary only to remove the wheel, withdraw old lining by hand, and merely slip a new length

of lining in place. The brake shoes, which provide about surface, are made of a special nickel-chrome iron sufficiently flexible to conform exactly with the drum contour when braking pres

FALLING DIAMONDS

DIAMONDS actually fall from the sky. That real diamonds exist in meteorites has just been demonstrated for the first time by X-ray examination of hard, black erystals in a specimen from the celebrated Meteor Crater in Arizona.

The present specimen was obtained not long ago by the Smithsonian Institution, and me of the suspected diamond inclusions were ground out. They were turned over to mineralogists of the Geophysical Laboratory of the Carnegie Institution of Washington for study by the most refined methods, with the result that the true nature of the inclusions no longer is in doubt

The conditions under which meteorites robably were formed would be favorable for the formation of diamonds, provided the requisite carbon was there in the first place.

Demonstration that the inclusions actually are diamonds recalls the futile efforts made to drill into Meteor Crater in the hope that a big diamond mass would be encou tered. After drilling straight downward for about 1200 feet the drills struck a resistant

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material through which they could not pene-trate. Efforts to sink a shaft were defeated by striking water. Geophysical experiments indicated a very heavy mass in the neighborhood. None of this, of course, would be accepted by geologists as positive evidence of the existence of a large diamond mass. There is even some question as to whether the "shooting star" responsible for forming the Meteor Crater actually penetrated the earth at all. It may simply have exploded and its fragments scattered over the neigh-borhood where many of them have been

picked up in the past century.

The diamonds found in the Smithsonian Institution specimen are not of gem quality. They are very good black diamonds—even more valuable than medium-rate gems be-cause of their use in industry.

SWEETS FOR HIGH-FLYING BOMBERS

SWEET emergency rations may be car-ried by pilots of bombing planes crus-ing at 11,000 to 20,000 feet altitude and ing at 11,000 feet allitude and peering at the darkness of a blacked-out city, to counteract difficulty in reading their brightly lighted instruments. This may be concluded from experiments reported by Dr. Ross A. McFarland.

Adaptation of the eye to dark and light is seriously affected by lowered oxygen pressure, Dr. McFarland and Dr. W. H Forbes found at Harvard University, but the effect can be counteracted by a dose of glucose. The eye fails to adapt normally because the amount of oxygen in the nervous tissue is decreased. The trouble is in the nerve elements of the retina and central nervous system, not with the photo-sensitive substances in the eye .- Science Service.

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DETECTOR

PAINTERS, plasterers, architects, build-I ing managers, waterproofing contrac-tors, and others will find use for a new and simple instantaneous moisture detector announced by Colloid Equipment Company,



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Inc. It is used for testing plaster, brick, or lac. It is used for testing plaster, Drick, or concrete surfaces before decorating them, or for tracing leaks. It gives instantaneous readings of "dry," "wet," or "very wet." This device is a simple electrical meter with an extension cord on the end of which

is a handle containing two projecting needles. These needles are punched into the surface being tested, thus completing an electrical circuit. The flow of current between the needles and through the wall at that point will thus register on the dial of the meter without any calculations, the amount of current flowing being dependent upon the moisture of the wall. The circuit used is said to insure the highest possible accuracy regardless of whether the enclosed battery is new or old. The dial may be calibrated to meet special conditions.

YAWLS FOR THE NAVAL ACADEMY

AS a result of efforts over a number of years of high Navy officers to obtain up-to-the-minute sail boats for the Naval Academy for instruction in seamanship, the Luders Marine Construction Company



Practical seamanship is learned by midshipmen on yawls such as this

was awarded on their competitive design the contract for building three Navy

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Each of these boats is 44 feet overall. 11 feet beam, and 6 feet draft, with 965 square feet of sail and 9000 pounds of lead in its keel. Accommodations are for eight mid-

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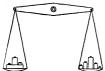
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THE PROBLEM OF THE WEIGHTS

ONTINUING our series of mathemat ical brain-teasers, we offer the Prob-lem of the Weights. It is, according to the suthor, a paraphrase of one which is over 300 years old, and one of the few really good problems in arithmetic. The answers and the solution will be given next month. Meanwhile any correspondence concerning this or previous problems should be ad dressed to Lieutenant Commander Leonard Kaplan in care of Scientific American, 24 West 40th St., New York, N. Y. All letters will be forwarded unopened.

It is desired to obtain a set of eight weights for a beam balance such as is show in the accompanying sketch. They are to be



used for weighing to the nearest ounce any object up to, and including, 205 pounds. Each may be used on the left scale pan, or on the right, or not at all. The problem consists of three parts as follows:

I) Determine the magnitude of each weight. II) Prove that eight is the least number,

and, that III) These eight weights have the least total weight of any set which will fulfill the conditions of the problem.

Heavy, oily liquid of dark straw color. Evaporates slowly at ordinary temperatures; thus is a persistent type of gas. Frequently diluted with another poison, chloropicrin, to keep it liquid in colder weather. Has a delayed action on body. First symptoms, stching and blistering. Especially damaging to eye's cornes. In eye, tissue degeneration begins two minutes after exposure to dilute concentrations. If gas is swallowed, symptoms of nauses, vomiting, and diarrhea develop. Gas very penetrating. Goes through ordinary clothing, rubber, and even leather. Is 50 times more toxic than chlorine.

Chlorine Gas. First gas used in World War, Two and a half times the weight of air. Clings to ground. Fills shell holes, depressions, and dugouts, Greatest action oc curs in presence of moisture. Major action is on respiratory tract with symptoms of

choking, coughing, and suffocation.

Phoagene Gas. A combination of carbon monoxide and chlorine. Resembling chlorine in action but has a more delayed effect. In 10 times more toxic than chlorine. First symptoms very minor. Its effectiveness mainly due to initial innocuous character. Its mensoe is revealed only after considerable gassing has occurred.

aute gassing has occurred.
Lessistic Chemically, chloro-vinyldickloro-arrian. Developed secretly during.
World War hy Capt. W. Lee Lewis of U.S.
Chemical Warfare Service. War ended just
before gas entexed sembet use. Has all
bilitizing geoperates of masterd gas but

more effective because it has ability to penetrate the skin. Three drops, placed on rst's abdomen, causes death in two to three hours. Is powerful respiratory irritant. Produces violent sneezing. Another variety, bets-beta-prime-chloro-vinyl-dichloro-arsine, has less blistering effect but its irritation on

respiratory system is much more severe.

Toxic smokes. Chemically, diphenyl-chloro-arsine and diphenyl-cyano-arsine.

Popularly called sneezing gas. Are really finely divided dusts. Can pass through ordinary gas masks unless special filter at-tachments are provided. Effective in concentrations of one part in 10,000,000 of air. In higher concentrations, cause vomiting. Considered as poisonous as phosgene in

equal concentrations. Crying Gases. Twenty-three different varieties used in World War. All intended varieties used in world war. All intended to produce temporary dissibility and confusion. Favorite German lachrymatory gas was xylyl bromide. Among the Allies, chloropicrin was widely used.—Science Service.

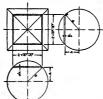
SOLUTION TO THE

PROBLEM OF THE

Intersecting Cylinders

THE problem offered last month was to I find the volume of the material removed from a two-inch cylinder by a two-inch drill. The axis of the drill was perpendicular to and intersected the axis of the cylinder.

Here, as was promised, is the solution The illustration shows the section removed



from the cylinder. The radius of the cylinder is equal to the radius of the hole and has been designated as a.

Taking sections in the manner indicated, the volume, V, will be given by the expres-

$$2\int_{0}^{a} (2\sqrt{a^{3}-r^{2}})^{3} dr$$

$$8\int_{0}^{a} (a^{3}-r^{2}) dr$$

which integrates into

And so for the specific value, a = 1 inch, given in the problem, the volume of material removed is 5 1/8 cubic inches.



answers both the personal and the astronomical ques-

tions." A. G. Ingalls

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YOUR TIREARMS

Conducted By A. D. RATHBONE, IV

INTEREST IN FIREARMS is traditional with American men; science has so developed them that millions yearly find aport and recreation in their use. Hence this monthly department presenting a wide variety of discussion regarding fiveams, their handling, and their accessories. Suggestions from readers will be heartily welcomed—The Editor.

INTRODUCTIONS ARE

IN ORDER

THE brotherhood of nimreds, gun fanciers, and gun hobbyists is one fraternity which particularly and readily leads stiedl to new and lasting firendships. This introduction of "Your Firearms" to Scientife American readers is performed, therefore, with the pleasurable anticipation of capaging with kindred souls in monthly round-table discussions and arguments in leasurable discussions and arguments in leasurable as it? "Your Firearms" we're going to discuss, we will endeavor to class about the things in which you are interested.

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BIRD SEASON SHOTGUNS

WHEN the old-time angler selects a new trust rod, he doesn't whip it as a David Harum might lay his baggy labe note the old mare's flanks. He picks it up with the same delicate reverence that a pewder imparts to the presentation of a beautifully made watch. He tests the rod's balance; the tip waves gently as, with an easy wrist motion, he gets the general "feel." Your experienced bird shooter handles a prospective shotgum purchase in much the same manner. It's the "feel" of the weapon which tells him what he wants to know

rells him what he wants to know. Incorporated in that "feel," however, are several factors, tabulation of which, to the vetran gunner, are more or less subconscious. The weight, balance, pitch, fit of stock, drop at comb and at hed are all integers which collectively contribute to an instantaneous reaction during the first moment or two with a new gun. The aforesid veteran is entirely conversant with these component items, but he doean't delive specifically into them until after he has applied his first automatic testing formula of "feel,"

Should the reaction he negative, even in the least degree, the piece is either laid saide in favor of another, or the purchaser hefts the gun, tries it rather questioningly to his shoulder again, as if that sliadow of doubt which first crossed his mind might have been an error. The chances are, though, that if the gun "feels" wrong, he can't be presuaded to try it, and if he does, the resultant lack of complete confidence will affect his shooting.

All this applies to the man who knows his guns. How then, to answer the novice, the new chap, who asks: "Which shotgun should I buy?" The logical answer to that one is, of course, another question: "What



The author afield

game do you want to shoot?" But this deasn't give the neophyte much satisfaction. However, we can say that stock fit, portability, trugger pull, gage, gun balance, lince, and certain minor mechanical details are primary features to be considered in selecing a field gun. Let the novice forget momentarily the more technical angle.

Regardless of weight, ager, halnee, or bore the gum must fit the gunner or the results will be disappointing. A beautiful and expensive field piece may be utterly useless if the stock is either too short or too long. The best we can say is to find a gun which feels "right" when it comes up to the properly fitted now sail of climbs—and stay with it long enough to give it an adequate trial. If, then, you can'that what you aim at, take it back for a cheed-up of all phasees.

We have listed portability, or weight, as the second item for consideration because who can walk three or four miles without feeling tired. In our estimation field guns should range between 61/2 pounds and 7 pounds 6 ounces when empty, and while that may not seem like much gun to carry, there are also shells, frequently heavy cloth-ing and, it is to be hoped, some game.

Trigger pull in your shotgun is as imortant as acceleration in your motor car. Both are vital factors in performance and safety, and, just as acceleration in automobiles is not always satisfactory, so in many shotguns the trigger pull will not be perfect. A 4 to 5½ pound trigger pull on a double barrel, 12-gage gun weighing around seven pounds will be found to be pretty close to correct, and although lighter pulls in lighter pieces may be smoother, too much reduction in the pressure brings in the problem of accidental discharge,

As to gages, it is quite universally agreed that the 12, 16, and 20 are the popular sizes in field guns throughout the country. To attempt to designate whether that new gun should be an automatic, a pump, a double barrel, or one of the over-and-unders would be rather like trying to tell the trout fisherman which fly to use. We do feel, though, that if you've been used to rifle shooting, you will find the single sighting plane-that is, the pump, the automatic, or the over-and-under-better suited to you. Regardless of which gun is eventually

chosen, remember, it is like your golf clubs, your tennis rackets, your trout or bass rods. All require constant use and practice to get the most out of them, and that, we might observe in closing, is one reason why we have so many skeet fields.

Pot-Shots

AT THINGS NEW

WINCHESTER AND WESTERN SUPER TRAP AND SKEET LOAD now available in standard shells featuring a new crimp. In this deing a card wad over the shot, these com panies have joined Remington, who an-nounced their new crimped shell last spring.

Using two cameras taking instantaneous ultrs high speed exposures, the two accompanying pictures by flash photography show how the shot charge from the same crimpedhow the shot charge from the same crimpeu-shell load is propelled targetward—from right to left. The upper photograph looks down at the charge from an angle of 45 degrees, while the lower photograph looks up at the same angle. Use of the crimp has eliminated the top wad, conspicuous by its absence in the illustrations, and with no such source of interference to expand or ecatter the charge, there can be no so-called "doughnut" patterns. Attention is called to the Seal-Tite wad, which has served as a pistun, and which is seen dropping away om the charge.

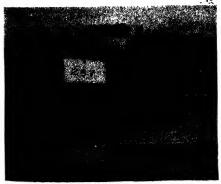
Averages taken from 100 fired 30-inch patterns at 35, 40, and 50 yards showed ow the spread of the original dense pattern center is controlled, resulting in remarkable uniformity of the number of pellets in the outer six-inch ring of the 30-inch targets. The averages were as follows:

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3-inch shells and is full chuke, with spe fications similar to the .410 over-and-under - 1 Table 1

shotgun. The Marlin factory will also fur nish on order 278 Bee or .22 Hornet barrels in combination with the .410 bore and either of these can also be fitted with an extra set of .410 bore, 26-inch barrels.



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TRICKS BY

REFLECTION

ROM the simple reflection in a mirror or body of water, to the many and waried surfaces in which an object in reflected by the familiar "agency of light," photographs by reflection have been a popular pastime for a long time. Their popularity never pales because of the great variety of effects that may be obtained. There is no great that may be obtained. There is no great that may be obtained. There is no great manually problem to surround, but there are frequent instances in the work of anaetters where a better understanding and appreciation of reflection photography would have improved the result.

At the moment, we can think of five principal things that should be taken into account in producing good reflection piotures. These are as follows:



Figure 1

 The light used should illuminate the subject and be shielded from the reflecting surface itself as much as possible, for wherever the light strikes the surface the subject reflection is partially or totally lost.
 In focusing for the reflected image, the focal point is not the face of the reflection of the reflection of the re-

subject resection is parallely for totally join.

2. In focusing for the reflected image, the focal point is not the face of the reflecting surface, but twice the distance from the position of the subject to the reflecting surface. However, this will obtain only from the point of view of the subject. That is, it would be true if the engane were placed alongside the subject or at some point to the left or right of the subject, on a plane with the latter, equally deleast from the left or right of the subject, on a plane with the latter, equally deleast from the cases, the more practical way to put it is to say that the polat of focus is the distance from the subject to the reflection is to deleast the polat of focus in the distance from the distance from the surface plane the distance from the surface.



Figure 2

3. The angle of the camera should be such as to make the most of the reflection, which is the chief reason for the picture. This may sound like unnecessary advice because reemingly so obvious but a glance at some reflection picture efforts will show how frequently these pictures show the reflection in a position of minor emphasis.

4. Adequate exposure for the reflection, depending on the reflecting capacity of the particular surface used, is another point to watch. An exposure that will be correct for the subject itself under a given intensity of light will not always be right for the reflection. A mirror or calm body of water will give off the brightest reflections, practice.



Piguto 3



Figure 4



Figure 5

tically equal to that of the subject direct. A less efficient reflector may take twice as much exposure or more.

5. What cannot be accomplished com 5. What cannot be accomplished completely by point 3 in the matter of properly composing the reflection picture should be done in the printing or enlarging through "framing" or masking. More than is desired way be included in the picture because of the food length of the lens or because of an enforced diseases from the subject exciton. The property of the property

trick effect is an ordinarily straight resoci-ing surface—mirror. A celling compris-ing a member of separate mirrors joined togather "hreaks" sand duplicates subjects "sharewer the inter appear at the mirror joine. The stiple "straw"-like units are tubular lenge. At night an ordinary window will serve as

a reflecting surface almost as efficient as a mirror. Witness Figure 3, in which a desk and chair, even the door of the room, are faithfully reflected in the window, through taithinity renected in the window, into also may be seen the lighted windows in buildings in the distance. Inclusion of the window helps to clarify the picture.

A curious trick effect is shown in Figure

4, which was photographed through a window facing the street at the other end of an empty store. The late afternoon sun coming from the direction of the window shown in the picture illuminated the buildings reflected in the left third of the picture.

Figure 5 is an example of distortion by

reflection and foreshortening, or close view-point. The reflecting medium is an aluminum surfaced coffee pot. The odd vertical reflection is the face of the subject, which was reflected upright from the convex part of the pot and inverted from the concave upper portion.

DOUBLE-DUTY

FILTERS

PERSONS who own both a Contax and a Super Ikonta B are advised that a threaded adapter ring is available for the latter camera which will take the same filters as those used on the Contax, as well as the lens shade. Thus, the filters purchased for the Contax will serve for the other camera as well, eliminating the nesity of purchasing a separate set of filters for each of the two cameras.

GROUND LEVEL VIEWPOINT

ONE of the most frequently heard taboos is the one that advises never to have the camera face the subject head-on because such a pose is bound to lack interest. However, like other rules and regulations mete out to photographic workers, this one may sometimes he broken with impunity. Here NO OTHER MINIATURE CAMERA OFFERS SUCH VALUE!

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2. Prints must not be smaller than 5 by 7 or larger than 11 by 14 Prints need not be mounted, but may be at

2. Photographs must be packed properly to protect them during transportation

4. Non-winning entries will be returned only if sufficient postage is included when the prints are submitted.

5. Each entry must have the following data written on the back of the print or mount. Name and address of contestant, type of camera and film, enlarger and paper used.

6 Contestants may submit no more than two prints in each group, but may anter any or all groups.

• 7. Prints must be in black and white Color photographs are not eligible

e 2. Prise-winning photographs will become the property of Scientific American, to be used in any manner at the discration of the publisher

scientific American reserves the right to purchase, at regular rates, any non-winning entry e ? Scientific American

10 No entries will be considered from professional photographers

e II All entries in this contest must be in the hands of the judges by December 1, 1939 Results will be announced in our issue dated February 1940

12 This contest is open to all amateur photographers who are not in the employ of Scientific American.

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THE JUDGES: McClelland Barcley, artist Ivan Dmitri, artist and photograp Robert Yarnali Richie, commercial photograph is one that we believe does so successfully. Taken on the beach in mid-afternoon, the cameraman crouched on his tummy to face the subject eye to eye and shot away just as a fortuitous breeze waved the towel revealingly out of the way. The arrangement of the towel around the subject's head, the



From ground level

revelation of only one shoulder, the highlight on one side of the face, the waving hair, the pose of the subject's left hand and the curious smile, each lends its bit towards the whole. Unfortunately, the right hand, holding the lighted cigarette, is out of focus owing to too near a camera viewpoint and the wide diaphragm opening necessitated by the fact that the subject was in shadow

PRIZE CHANGE

DUE to war time conditions in Europe. and uncertainty as to shipping schedules, we are forced to make a change in the First Prizes offered in our Fourth Annual Photography Contest. As originally an-nounced, First Prize Winners would make their own selections of watch styles from the line of \$250 "Lifetime" Longines watches. Now, however, this must be changed and as conditions stand at present, First Prize Winners will be presented with \$250 "Lifetime" watches in the pocket style. Second Prize conditions have not been changed.

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OCCASIONALLY the beginner comes tion," and wonders about its meaning. In preparing a saturated solution, a sufficient amount of the chemical is poured into a quantity of water so that some of the chemical is left undissolved. In other words, pour in a little more chemical than a given quantity of water will dissolve. The amount of chemical required will vary with the temperature—the warmer the water the more chemical will be needed; the colder,

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the center of this cover cut a hole and insert a tin or cardboard tube. When you have attached the cover to the front of the light and anapped on the switch, a narrow beam of light will be the result. To control the angle of this beam, you may have two tubes, one aliding within the other. The longer the extension used, the narrower will be the beam.

SPORTS BY

Synchro-Flash

DESPITE the growing popularity of synchro-flash photography, in which snapshots in daylight are made with a flash gun, the photographer employing this means frequently is questioned as to the reason for using a flash when there is available



By synchro-flash

such a largess of daylight. Such was our experience one day as we were synchroflashing an outdoor game. In order to get a good ione in the sky, we employed an orange filter. The picture was made as the player struck the ball with his fist. The use of the flash helped to balance the light between the shadow areas and the sunlight. We expect shortly to present an article on the general subject of synchro-flash pho-

DUSTLESS TANK

REELS

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SUCCESS STORY

TO date Nathaniel Field, 33-year-old Brooklyn, New York, accountant and perennial picture-prize winner, has carned and won a total of about \$1,500 in cash. prizes, and merchandise. His latest victory



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was the capture of a first prize in the Ford Exposition's Fabro Content at the New York World's Fair. Mr. Field, who is believed to have embacked on a photographic hobby career with the birth of a son about two and one half years ago, started with a very inexpensive camera, and kept trading in for better ones until, about eight months ago, he bought his present camera, an enlarger and all that gow with it, and started doing all his own work.

Mr. Field worn to prizes in the National

M. Field won two prizes in the National Motor Truck Show last winter, and his flash picture of a grtl on a circus horse was awarded the \$25 first prize for the "Best Picture-O-the-Month" by Popular Photography. Many firms have hought pictures from him for use an advertising or pronound work. The New York Central Rail-road bought a series he made inside Grand Central Station. At this issue goes to prese learned for the Central Station of the Stational Park Stational Central Station. The second control of the Park Stational Central Station of the pictures has been selected by Edward Steichen for the 1940 edition.

WHAT'S NEW

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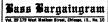
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JACOB DESCHIN, conductor of our "Camera Angles" department, will answer in these columns questions of general interest to amateur photographers. If an answer is desired by mail, enclose a stamped, addressed envelope. Queries should be specific, but Mr. Deschin cannot undertake to draw comparisons between manufactured products nor to advise on the purchase of equipment or materials.-The Editor.

O. I have heard that the backs of negatives may be so treated as to permit working on them in order to modify the image. Will you please plain how this is done?—C. S. K.

A. Prepare the following formula: 18 grains Sandarac Mastic 4 grains200 minims Ether Benzol 80 to 100 minims This is spread evenly over the back of the When dried, the resulting matte negative. permits the application of chargoal or crayon for the purpose of intensifying details or masses, adding clouds, and so on. The fineness of the matte surface is determined by the amount of henzol used, the greater the amount, the finer the surface obtained.

- O. How long does it take for brown stains to appear on a print that has not had the hypo properly washed out of it?-F, L, D,
- A. No definite answer is possible, for it will depend on the amount of hypo left in the print and might take a few months, a few years, or longer. Of course, you know that various tests are available for determining whether a print has been washed free of hypo.
- Q. I have been trying to use my camera, which takes vest-pocket film, for copying the printed matter in books, magazines, and so on. Employing Mazda (not Photoflood) illumination and the standard orthochromatic and panchromatic films in the standard fine grain developers has proved unsatisfactory, the enlarged prints being grayish and muddy from lack of contrast even when a hard paper is used. Would you advise getting a 35mm camera so that I may use positive, process, and other films of a contrasty nature? Or would a contrast developer, such as D-11, on film such as Panatomie X prove sufficient-ly contrasty for crisp prints?—J. R. B.

A. For best results, showing clean-cut reproductions of the printed matter copied, positive film will be the most satisfactory. Development in the contrast developer D-11 at 65 degrees for five minutes, should prove

The fault has not been in your lighting,

which is probably satisfactory, provided it is evenly distributed over the surface to be copied, but in your choice of film. In this type of work not only do you have no need of the color sensitivity of orthochromatic and panenromatic films, but this actually is a deterrent to satisfactory work. You might try the suggestion contained in the last sentence of your letter and see if the resulting contrast is sufficient for your purposes, but positive roll film in a 35mm, camera, or positive cut-film in a larger camera, will do the job in the most efficient way.

O. Infra-red film with filter calls for 1/20 of a second at f/3.5. I have a Goerz Dagor f/6.8 lens. What will the exposure be for this lens at its widest opening?-M. S.

A If the exposure you cite for 1/35 opening is correct, the exposure at \$/6.8 will be four times as long, or, in this instance, 1/5th second.

Q. I have the opportunity of pur-chasing an old model camera, with a Tessar f/4.5 lens, which takes a sixexposure roll. The red window is in the middle center of the back. In examining the camera I find that the back acction of the lens has been removed. How good is this lens with the two front elements only? Could you tell me if the aix-exposure roll is easy to buy? I have the idea of using the 120 roll but I am not sure whether the numbers which indicate the exposures are marked all the way across the safety paper.-A. P.

A. The lens cannot be used as it stands because the Tessar is of the so-called nonsymmetrical type and therefore requires the use of all four elements which comprise the Tessar. The six-exposure roll is not now available in this country. By some experimentation, it is quite possible for you to work out a scheme whereby you could em-ploy the 120 or similar roll-film size. The number markings on the back of the safety paper now include three rows, the left for the 8-exposure style camera, the right for the 12-exposure camera and the center for so-called vest-pocket, 16-exposure cameras. For your particular camera, because the window is in the center, you will have to use the center row as the basis for working out your particular requirements.



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Figure 1: Holcomb's heavy mounting

amount of time on an optical surface until it is as nearly perfect as any optical surface concernment. In few communities such concernments, the few communities such cluded or are concluding arrangements with local educational institutions—hip almost colleges, universities—to make and institution concernments, the educational institution concernments the few discussions of the few motified advantage. For example, the educational institution concernments the for the observatory. The amateurs put in the skill and the elbow grease. The finished observatory is then available to both coften also; to local townsment).

totten, also, to local townsmen).
The 12" reflecting telescope shown in Figure 1 was made by an amateur, J. M. Holcomb, 40 Clarke St., Burlington, Vt., for St. Michaels College in Burlington's suburb, Wincoakl. Asked to describe it, Holcomb states.

"The mounting is compact and rigid, operates smoothly, and is convenient to use. The setting circles are divided to half dogrees and are illuminated. The driving clock (Figure 2) is run hy a synchronous motor and is adjusted to sidereal time. The mounting is also provided with also motion controls, that in declination heng manual, that in right ascension motor driven.

"The building (Figure 3) consists of a 12 by 26' classroom on ground level and a wooden-framed, metal-sheathed dome 12' in diameter, 9' high, above. The telescope rests on a ten-ton reinforced concrete pier entirely free from the building, in order that no vibrations may be transmitted to the telescope

"I believe the unit can be termed an amateur job, despite the fact that I did not actually lay the bricks, mux the concrete, or pour the iron castings for the mounting. I did design it all, also made the patterns, supervised the masonry, and did the rest of the construction.

"The mounting contains a temporary 8" mirror made by Father A. Rivard, S.S.E. of St. Micbaels College, but a 12" mirror is being made."

The rugged proportions of Holcomb's

mounting design are worth close study. This telescope will not shave, as many do, when a fly alights on it. A telescope mag-nifes its own whatians just in the measure that it magnifies the stars, hence whatians that remain wholly invashle to the direct look cause the stars to dance wildly to the look through the telescope. This is why ordinary enters for rapidity in machines, supports, and so on, are much tow weak for telescope mounting design. A telescope mounting design.

INITH in a long line of sight Noutons una rangeng from 4" to 12½", and from 1/5 to 1/18, and hull over a period of four years, a shown in Figure 4, with its maker and owner, John J. Stoy, 450 Hutt Bulding, Atlania, Ga. In his letter Stoy styles himself "Director of the Smoky Holow Freshar Observatory," The telescope is a 12½" of 1/8, and the total weight of elescope and piers is 3550 pounds. The design is conventional but unusually clean. The polar aris counterveight, 'Stoy writes, "is open to argument as to necessity, but it brings the center of mass to the center of the pier." This last idea seems excellent, and in keeping with principles of mounting design started by Porter in the treatise "Amandia Ratery Making," fourth edition.



Figure 2: The electric drive

Close inspection of the figure will reveal a very smooth, clean declination ans caring and union for tube attachment. These were cast in fron, from patterns made and donated by Fred Ferson, Blozi, Miss, author of the chapter on modifing and casting, in "ATMA," and a friend of Stoy's. The upper end of the tube rotates. The tube is venulated through an oversized cell with 9-point auspension.

How well your scribe realls the day when Stoy received and began working the 12½" Pyrex disk for this telescope, which, it seems, was past as bit hubbly Daily thereafter the mails brought generous samples of the most competent old-fashioned southern cussin', but finally Stoy learned to defeat the bubbles and the profassity imperceptibly dwindled until, at last, he actually came around almost to loving Pyrex. Even now, however, you must smile when you sy "hubbles" within his hearing. (It is impossible to cast Pyrex disks without some bubbles—can't pat is the enough and fluid enough, because of its high melting point, for all the bubble to rise—but the makers throw out the poer clishes. Stop also before used his mirror touce after most of the world would be the called it a day—we asspect would be the called it a day—we asspect would be the called it in the called it is a day—we asspect would be the called it in the called it is a day—we asspect would be the called it in the called it is a day—we asspect would be the called it is a day—we also show that the called it is a day—we have a day of the called it is a day of the called i

THE following communication is from James G. Baker, of the Harvard College Observatory:

"In reading through the very interesting article by Hendrax and Christie in the August Scientific American the present writer has noticed some incompleteness that might cause amhituous amateurs a bit of graft. All the various types presented by the authors are certainly workable, but caution must be exercised in order that cameras constructed should not exceed in aperture that which is justifiable theoretically.

"The thick mirror type discussed (Figure 3, IX in the August article) is optically inferior to both the ordinary and the solid kinds of Schmidt camera, although still quite a good camera in Itself. The authors have failed to point out that the position of the apparent center on the axis depends upon the angle that the incoming rays make with the optical axis, and that this type of camera does not possess the symmetry of the Schmidt arrangement. Just as in the case of the usual Schmidt the third order errors are zero, which fact insures good performance, hut, optically speaking, the thick mirror is not aplanatic he the third order, whereas the Schmidt is aplanatic to all orders of accuracy. The practical effect of this lack of perfection is to limit the speed and usable field of the caniera, as compared with the Schmidt in glass. By a suitable deformation of spherical mirror and intermediate refracting surcas minor and intermediate retracting sur-face, one can obtain nearly Schmidt per-formance, but the required optical work is more involved. The Zeiss company has re-cently produced a thick mirror system involving only spherical surfaces that has a flat field. The authors of the August article have neglected to point out that, as in the case of the usual Schmidt, the thick mirror type has a curved focal surface, spherical and concentric with the spherical mirror



Figure 3: Observatory, St. Michaels



Figure 4: Stoy and his "Bessie"

face and should be made so. The authors state on page 119 that the speed of an //0.66 camera can be obtained with the field and correction plate curvature of an //1 of the usual kind, but this is not correct. The depth of the correcting surface is exactly n times deeper, zone for zone, than for the usual Schmidt of the same physical size, and the usable field about a times larger, angularly, in the case of the solid schmidt, and about the same in the case of the thick mirror system, all compared with the usual Schmidt. The letter n used above stands for the index of refraction of the glass of the thick mirror. The index of refraction that sppears in the denominator of the expressions for the correcting surface will be that for the glass of the correcting plate, in the above thick mirror system.

"The performance of the Schmidt in glass is truly remarkable. The solid glass combination was discovered independently and was investigated through its fifth order image errors in May, 1938, by the present writer, and discussed at the October, 1938, meeting of the Optical Society of America. The solid Schmidt, I have heard indirectly from Bergedorf Bergedorf Observatory, in Germany, where Schmidt worked,-Ed] workers, was contemplated by Schmidt himself, some years ago. Sinclair Smith seems to have been the successor to Schmidt in coming upon the solid Schmidt, but the pubheation was delayed by his untimely death fortunately concluded that the thick mirror type constitutes the only practical way of getting to the focal surface, as Hendrix did also in the early stages of his work. Hendrix, however, has now provided an intype. An off-axis type provides another.

"Let us compare the solid Schmidt with the ordinary Schmidt of the same physical size, that is, with the same aperture and radius of the mirror surface. The focal length is 1/n that of the usual Schmidt, the people of greater, the depth of the correcting people of greater, the depth of the correcting matic aberration disk a times smaller as each wavelength, and the curvature of the field the same. The third order sulgmatism, resistance of the same that the theory of the correcting plate, is alightly smaller than that for the usual Schmidt, and for both is numerically of the fifth order. The first the ordinary schmidt is the variation of spherical aberration with angle. This detect is several times smaller for the solid Schmidt shap, for the usual kind. The

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THE BUILDINGS COUNTR

IF you are tempted to jump from your first 6" telescope making job to a much larger size, the accompanying photographs and description by a worker who jumped



the other way and put his energies into refinement may be worth considering. It is a 4" made by L. J. Ashby, 437 Stone St., Kalamazoo, Mich., and by Mrs. Ashby, and is equal in both design and finish to profesis equal in both design and mining to profes-sional work. Both, we say, since we have seen a few telescopes with very exquisite or even over-elaborated finish but poor de-sign. Ashby, who has been a telescope maker for several years, writes:

"There are a few who want a really porta-ble instrument—one which does not require several strong backs and a truck to handle and transport. My wife cannot conveniently carry around even a 6", hence this 4" Newcarry around even a 6°, hence this 4° New-tonian which carrise easily in the family car and can be handled by a woman. Some details are: Mirror made by Mrs. Ashby, with much oral but no manual assistance on my part. No scratches. Tripod, wood. Set-ting circles, graduated 5 minutes and 2°. Slow motions in both directions—in R.A.

lined for better temperature performance. Rack and pinion focusing. Level and com-pass for quickly aliming polar axis. Finder, diagonal type, 7X, 5° field. Eyespicoce, 1°, '4', '4' (after Clarke, in 'ATMA.). Fladd of view with 1" cycpicoe, 1½'. Tube wt.,



111/2 lbs., mount and counterweight, 27 lbs. Cost, \$35. Time, 210 hours.

"This little telescope resolu of Epsilon Lyrae with '%" eyepiece, Pr

After all, no beginner on his maiden teles-cope should attempt so fine a job as the Ashbys' but should aim to equal its design Ashbys' but should aim to equal its design for rigidity, especially at two vital places: on the declination axis near the tube, where a large cross-section is here seen, and in the plate between this axis and the tube, which is here amply thick.

A little telescope, but built like a watch.

ANOTHER TN (which stands for Teles-cope Gnut, socially correct designa-tion for telescope makers.) who, after making the beginner's 6", did not seem to drop to a 4" because of its portability, is G. F. Hofferberth, R. F. D. 3, Dayton, Ohio, a rionerberin, R. F. D. 3, Dayton, Unio, a telescope maker of long standing and now owner of a 12" Cassegrainian. It has a tube of copper sheet which was rolled, the edges scarfed and silver-soldered. The finish ("engine finish") was done on a drill press with a rubber grommet, oil and emery. Hof-ferberth made the patterns and did the ferbeth made the patterns and the imachining for the polar axis support and bearing and for the well-proportioned fork, but the very beginner—the absolute tyro need not worry about such refinements as the latter, since easier methods are available.

TELESCOPTICS

(Continued from preceding page)

are all zero with exception of spherical aberration, as in the case of the usual Schmidt. The front surface of the solid Schmidt. The front surface of the solid Schmidt behaves as saingle prime face, so that, for large field angles, a star photo-graphs as very short spectrum. This defect is of no importance in spectroscopy, for which such a glass camera is most useful. The Harrard Observatory has under con-traction a solid off-sair Schmidt, for which the focal ratio has been pushed to the ex-treme of 1/0.30. The focal length is ISmm, and the tushle field smil linearly, or about 12 decrees. The field is still larger for re-12 degrees. The field is still larger for re-

duced aperture.

"A variation of the Schmidt in glass is offered by converting the apherical mirror.

into a spherical lens surface, with a cor into a spherical lens surface, with a corre-sponding change in the depth of the correc-ing surface. Because of the small power of a lens surface of the same radius as a mirror surface, as compared with that mirror, the aperture-ratio of this type camera is limited to 1/1.5 or allows. It is, nevertheless, a true Schmidt camera. The focal surface is spheri-cal and conceptic with the large surface.

Schmidt camera. The food surface is spherical and concentrie with the lass surface.

"In the article by Hendrix and Christic even for the folded type, they mention a plane food surfaces to be made occurs it among the correspines surfaces to be made to the tendency of the control of the cont

gether the complete story. The Wright type, in addition to having double the chromatic trouble of the Schmidt of the same focal length and aperture, has astignation of the third order, that seriously limits the field at high apertures. As the authors state, cameras of //3 and //4 are satisfactory for limited fields, but then there is no need to make one in glass. For spectrographic purmake one in glass. For spectrographic pur-poses, the Wright type, called apocifically the "short" type to distinguish it as one of a family presented by Wright, also has a curved field, and on that surface third order satigmatism along the apectrum is zero.

The present writer would like to caution the amateur, who is contemplating a very the amateur, who is contemplating a very iast camera, to compute his correcting aur-face from the more accurate formulas given by Wright in 'ATMA,' and to try contacting some person who has made a Schmidt to rheck the computation. If the amateur makes a solid Schmidt, he should use the ordinary formulas for a correcting surface, but with a factor of n, the index of refraction, throughout, so that the correcting plate is n times deeper, zone for zone, than is the case for the usual Schmidt. Moreover, the position of the focal surface must be carefully computed.

"Hendrix and Christie mention that the essest form of correcting plate to make is one for which center and edge are at the same height; that certainly must be correct from their wealth of experience and practice, but I would like to point out that the departure from the nearest sphere (one through center and edge) is nearly independent of their parameter k and, therefore, that the amount of aspherical figuring is

"The above is in friendly criticism, with sn eve toward aid to the amateur, and in no way should detract from the excellence and usefulness of the article as a whole."

In his letter of transmittal, Baker states that he has the entire set of quantitative formulas that bear on the Hendrix and Christie designs and will be willing to cooperate with any amateur desiring information, who is really serious about making some of these telescopes. In each case, he states, the many factors should be carefully balanced before the maker starts pre-cipitously on a part not justifiable theo-retically. He will give information to anyone wishing to know about the performance of a Schmidt of given specifications, or will recommend specifications to fit a given need.
He has also designed a family of flat-field cameras, equivalent in performance to the Schmidt camera, which he described before the American Astronomical Society last summer

Priority on (1) the fact that the correcting lens of a Schmidt should be made larger than needed and masked out, to facilitate the work, (2) the use of a liquid on the correcting lens while it is ground to shape, also use of a pattern of straight lines at the also use of a pattern of atraigm mass e-plate holder, and (3) the interpretation of the zones by the method just described, all described in the Hendrix and Christie article of last August, is claimed by Arthur De Vany, 727 Sylvan Court, Davenport, lows. In letters offered this department for lows. In letters offered this department on publication long ago, De Vany described these methods. Owing to your scribe's pro-crastination in publishing them they were offered to Reputer Astronomy, which published them a year or so ago, and it is now desired to mention the matter in order as



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BETTER OUTLINES FOR YOUR HOME MOVIES is a 15-page booklet describing the Effectograph and its various uses in getting special effects in amateur movie-making. Besbee Products Corp., Trenton, New Jersey.—Cratis.

THIS PROBLEM OF FOOD, by Jennie I. Rowatree, is a 32-page illustrated pamphlet which discusses the basic principles of diet with comparisons of dietetic habits of Americans and other peoples. It shows particularly the effect on nutrition of inofficiencies in diet choice. An encouraging conclusion drawn from this booklet is the "a good diet does not mean eating things we don't like." The Public Afairs Committee, 30 Rockefeller Pleza, New York, New York.—10 cents.

PROCREAS THROUGH CO-OPERATION, by Edward R. Weiddein, is a four-page folder that outlines briefly yet succinely the history and development of laminated safety glass. It tells also of the coordinated industrial effort which has made possible the hugh-quality safety glass of today. Melion Institute, Pittiburgh, Pennytosnia.—Graits.

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LEGAL HIGH-LIGHTS

Patent, Trade Mark, and Related Legal Proceedings That May Have a Direct Effect on Your Business

> By ORSON D. MUNN, Litt.B., L.L.B., Sc.D. New York Bar Editor, Scientific American

PATENT CHANGES

THE changes made in the Patent Law THE changes made in the during the last session of Congress were designed primarily to shorten the period between the completion of an invention and the issuance of a patent covering the invention. The most important change in the law relates to the very important twoyear period. Heretofore a patent application could be filed within two years of the first publication of an invention or within two years after an article embodying the invention was placed on sale or went into public use. Under the amendment to the law the period of two years is reduced to one year after August 5, 1940.

Another amendment which is corollary to the above amendment and which goes into effect on the same date relates to th practice of copying claims from issued patents for interference purposes. Ileretofore a person claiming to be the inventor of certain subject matter covered by an issued patent could copy the claims of the issued patent within two years of the date thereof. This period has now been reduced

Another important change, which became effective on October 5, 1939, relates to the simplification of interference practice. An interference is a proceeding before the Patent Office between two or more claimants for patents on the same subject matter to determine which claimant is the prior inventor. Interference proceedings are necessarrly involved and frequently consume a reat deal of time through no fault of the Patent Office, with the result that the issuance of the patents involved is delayed. Prior to the change in the law, interference edings were heard in the first instance by an Examiner of Interference. An appeal could be taken from his decision to the Board of Appeals of the Patent Office and an appeal could be taken from the decision of the Board of Appeals to the Court of Customs and Patent Appeals or in the alternative a suit in equity could be filed to compel the issuance of a patent. The intermediate appeal to the Board of Appeals has now been eliminated and the interference is heard in the first instance by a board of three Examiners of Interference rather than a single Examiner of Interferences.

A fourth amendment to the law empowers the Commissioner to require a responsive amendment to be filed in connection with pending patent applications in a shorter time than the six months previously allowed by the law but under no circumstances in

A fifth amendment abolishes so-called re-newal applications. Heretofore upon the allowance of a patent application the appli-

cant had six months within which to pay the final government fee. If he failed to pay the fee within that period the application became forfeited subject to being renewed in an additional six months period upon the payment of another government fee. The original intention of the renewal provision of the Patent Law was to permit a poor inventor who could not afford to pay the final government fee an additional period of time within which to obtain the necessary funds. However, it has frequently been charged that the renewal provision of the statute was utilized by wealthy companies and individuals to delay the issua of a patent and thereby prolong the effective period of the monopoly. The renewal provision has now been abolished and the Commissioner of Patents now has the discre tion to receive the final government fee if paid within one year after the expiration of the six months period allowed for the payment thereof.

The sixth amendment to the patent law is intended to increase procedural efficiency and provides for transferring jurisdiction over the registration of copyrights on com-mercial prints and labels from the Commissioner of Patents to the Register of Copyrights. The provisions of this amendment become effective on July 1, 1940.

ALUMINUM

FROM time to time rumors have been resulting from the use of aluminum cooking utensils. It is interesting to note that the Federal Trade Commission has taken cognizance of these rumors and has filed a complaint against the publisher of pamphlets dealing with this subject, charging that the representations contained in the pamphiet deceive the publi-

The titles of the pamphlets involved are "Poisons Formed by Aluminum Cooking Utensiis" and "Are You Heading For The Last Round Up?" According to the Commission the pamphlets contained such state having seventeen carbuncles, threw out his fancy aluminum ware. The carbuncles dis-appeared"; also "Another fed his dog from an aluminum dish; the dog died from cancer of the face."

JOINT OWNERSHIP

THE weakness inherent in the joint ownership of a patent is illustrated by a recent suit for patent infringement. The suit was brought by the co-owners of a patent for a non-refulable drum for lubricating oil against a prominent oil refining company. The Court found that one of

the co-owners of the patent had previously entered into a contract with the oil refining company wherein he had granted a licens to the company to use the invention covered by the patent. The usual rule of law applic able in such cases is that a good and valid license may be granted by one of the coowners of a patent and thereafter the licensee is not liable to pay damages or profits for patent infringement to the other

In the case in question it was argued by the co-owners that a different situation existed because of a contract between the co-owners whereby each agreed not to dispose of his share in the invention without the written consent of the other. This agreement it was contended rendered it impossible for either of the co-owners to grant a license without the consent of the other. The Court concluded that while the agreement was no doubt binding between the parties it was not binding on the oil refining company in the absence of notice of the agreement. The Court found that as a matter of fact the oil refining company did not have such notice and that accordingly it was licensed to practice the invention covered by the patent.

GOLD MEDAL.

THE Commissioner of Patents has ruled that the words "Gold Medal" are not descriptive of various items of merchandise or of their characteristics or qualities.

This rule was handed down in connection with the application for the registration of the words "Eventually Gold Medal" as a trade mark for poultry, dog, and cat food The Examiner rejected the application of the grounds that the words "Gold Medal" were "descriptive of various items of merchandise that have competed successfully in expositions or contests and awarded gold medals."

An appeal was taken to the Commissioner of Patents who reversed the decision of the Examiner, holding that the words "Gold Medal" were merely suggestive of the characteristics of the merchandise and not descriptive thereof.

FOREIGN COMMERCE

THE Federal Trade Commission has recently shown an interest in unfair methods of competition in foreign com-merce. Thus, it has issued a complaint against an importing and exporting company charging that the company had in duced a Japanese manufacturer to misbrand Japanese-made optical lenses and fulsely t mark them "Made in U. S. A." The company is also charged with procuring foreign business by "negotiating the export of such falsely branded products to Cuban importers.

The Commission alleges that purchasers in certain foreign countries, including Cuha, have a preference for products made in the United States as distinguished from like products made in Japan, and that these countries grant reductions in import and custom duties on products made in and imperted from the United States. Under the circumstances the Commission charges that the company's practices are unfair and react to the prejudice of competitors and to the prejudice and injury of United States manufacturers of optical lenses.

ational Typewriter Exchange...... 291

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NINETY-FIFTH YEAR . ORSON D. MUNN, Editor

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NO one needs to be reminded of the important part played in modern water by the sirplane; newspaper stories are a constant reminder. The other side of the question, that of defense against the frightfulness of air raids, is equally important. It is vital to every nation that anti-sircraft guns be provided in efficient types and large numbers. The United States is, therefore, rapidly adding to its stores of guns, for defense against attack from the akies by a possible future enemy. Rapid and accurate fire characterize this deadily weapon for defense.

SCHEMINIC ALKENDON Chemister, 199 Vs. No. 5, entered at the New York, N. Y., Post Office as second class matter June 28, 1879, under the set of March 26 Hz. Acciditant enters of Vergat received by Science of March 26 Hz. Acciditant enters of Vergat received as the Science of Vergat Research of Vergat British rights received 8 subscription price 54 50 per year Chande 54 50 Foreign 55 50 Manuscripts are consulted at the state of Vergat Research of Vergat Research of Vergat Research (Vergat Research of Vergat Research of Vergat Research of Vergat Research (Vergat Research of Vergat Research of Vergat Research of Vergat Research (Vergat Research of Vergat Research of Vergat Research of Vergat Research (Vergat Research of Vergat Research of Vergat Research of Vergat Research (Vergat Research of Vergat Research of Vergat Research of Vergat Research of Vergat Research (Vergat Research of Vergat Research of Vergat Research of Vergat Research (Vergat Research of Vergat Research of Vergat Research of Vergat Research of Vergat Research (Vergat Research of Vergat Research of Vergat Research of Vergat Research (Vergat Research of Vergat Research of Vergat Research of Vergat Research (Vergat Research of Vergat Research of Vergat Research of Vergat Research (Vergat Resea

Personalities in Industry

Title automobile business has made the most amazing progress of any industry in the past two decades—and the least known part of it—the human side—is one of the most fascenating, stories in American business. For the automobile industry is literally a self-industry in literally self-industry in literally a self-industry in literally self-industry in litera

Mr. Foy is president of the De Soit Motor Corporation, vice-president of the Chrysler Corporation, and secretary of the Automobile Manulacturers Assoit ton. And he started at the bottom—but he's never forgotten the things he learned about people when he was out on the firing line as an automobile salesman in the days when you not only had to sell a man a car, but also sell him the idea of why he ought to own a car at all!

As far back as college days, Byron Foy was what you might call an "automobile nut". He had a httle four-cylinder car and he loved it. In fact, he liked cars so well that when he graduated he went to work as an automobile salesman in a Dallas factory branch, but he didn' wait around the sales finor for people to come in. He went out and made calls last af them.

When the company announced a nation-wide sales contest, Foy decuded he would have to sell in volume, if he was to compete against salesmen an the larger cities. Thus he went out after feet business—large corporations and on the city itself. Like the rising young a main in the popular Alger nowle of the day, Byron Foy won a coveted prize in that contest.

Then the factory sent him east as a traveling representative His eastern dealers said they couldn't sell cars in winter. "We can't make country deliveries in the snow," his men complained "Why not deliver the cars on sleds'"



BYRON C. FOY

Foy suggested And they were delivered, right to the fariners' front door. Sales increased.

Still later Foy went to the Pacific Coast and subsequently became presdent of the Reo Motor Company of California Later he returned east as a partner in the New York Chrysler distributorship.

Here he came to the attention of Walter Chrysler, noted for his encouragement of young blood in his organization. Walter Chrysler recognized Foy's promotional instincts and sound busi ness judgment, and brought him to staff headquarters. Under Fov's leadership. De Soto has become a potent factor in Chrysler Corporation sales, and when you talk with Byron Foy, you'll know just why. The fact that he knows people-the things they want and the motives that make them buy-is reflected in his talk, as well as his products, his advertising, and his relations with his men and his dealers.

There's nothing fancy about Byron boy's office, or about Byron Foy The office is sumply furnished. Papers never stay on his desk very long Foy is a bear for detail- but he goes straight to the most important tasks first talks easily, and he is easy to talk to. He believes in giving his executives complete confidence and responsibilities. Thus he not only surrounded himself with a strong staff, but the way in which he operates has helped make them strong Byron Foy is married, and has two children. Besides his family, his main hobby is still motor cars. Though for sheer exercise he rides horseback. the wheel is still his first love. De Soto salesmen in New York know that they can always "call Mr. Foy's office" when a little extra help is needed to make a De Soto sale to one of Foy's many friends. For Byron Foy, automobile company president, is still a great automobile salesman who gets a kick out of "closing a deal."

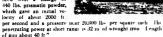
50 Years Ago in . . .



(Condensed From Issues of December, 1889)

CANNON—"The Spanish government, determined to emancipate the country from its dependence upon foreign nations for its munitions of war, has of late years displayed great enterprise in the establishment of works for the building of war ships and

cannon Among the guns lately turned out at Trubra are four which form part of the armament of the new Spanish steel cruiscr Pelavo Of these two are 49 ton 13 in guns and two are Il in Onc of the 49 ton guns, shown in our en graving, was lately proved The projectile used was of steel, weighing 960 lbs., fired with a charge of 440 lbs. prismatic powder, which gave an initial ve locity of about 2000 ft



TRANSATLANTIC. "The steamer (A1) of Rome, on her last trip out, made the port of Milford Haven nastead of Lwerpool, the magnificent system of locks, long under construction at that port, having been at last completed. The substitution of Milford Haven for Laverpool as a terminus saves the delay in steaming up St. Georgie's Channel and up the Mersey, and, more important yet, avoids the dangers of the channel fogs and the annoying delayoff the Mersey Bar. To London from Milford Haven such between tunnel u 285 miles, against 201 from Laverpool, it heing 1½ hourlonger by rail"

COAL DUST - "Heretofore about one-seventh of the product of the coal mines has been lost in dust. It is now intended to utilize the dust by making it into bricks that will burn like hard coal, except that there are no clinkers as the bricks burn to ashes."

FORE-ST GIANTS—"Plying on Paget Sound is a boat 122 feet long. The timbers of which the hull is built run from stem to stern, and not one is spliced. As a specimen product a Washington lumberman sent to San Francisco last year a heam 24 inches thick and 152 feet long."

PHEASANT—"The Mongolan Pheasant, a valuable addution to our native game birds, was imported from China a few years ago it has increased with surprising rapidity in western Oregon, Washington, and in the northwestern corner of California, under effective legislative protection. The plumage of the male is extremely brilliant and attractive. As a table dish it equals the partridge and prairie chicken of the Fast.

LUMINOUS FOUNTAINS. "Among the most wonderful displays, electric and wasul, at the recent French exposution were those pertaining to the luminous fountains, which were arranged on a grand scale. The claimeleous like changes of color in the fountain waters were wonething astonishing to behold. It was not accomplished by the mere throwing of colored lights upon the exterior of a spouring jet, but was due to an interior electric illumination of a spouring jet, but was due to an interior electric illumination and improved within the crystal wall of the water and then carried along with it, becoming visible by interior reflection during the discharge of the water."

PHONOGRAPH INSTRUCTION—"Edison's phonograph has scarcely, as yet, passed the period of "novelly and curiousty," but many practical applications of the instrument have already been auggested, and have in some cases been actually carried out There

so one application, however, that we have so far not heard mentioned, and that is the instruction in the pronunciation of forcing lauguages. In the future the publishers of menuals of instruction in foreign languages will find it, most likely, a paying undertaking to publish a phonographic key of the various exercises, thus enabling of the various exercises, thus enabling the control of the control of the control tion and pronunciation of sentence until it has been perfectly initiated by himself."

LABOR SAVING—"Some people denounce labor-saving machines as an evil They notice that a few individuals are put out of work for a time by the introduction of some device, but they ignore the greater benefits which the whole community obtains."

LIGHTHOUSES—"The Lighthouse Board has submitted its report for the fiscal year ending June 30, 1889, to the Secretary of the Treasury At the close of the year there were under control of the board 1021 lighthouses and lighted beacons, 1328 lights on Western rivers, and 4289 buoys of varous kind. In the main tenance of these there are employed 1934 light keepers and a number of miscellaneous employees."

WAVES.—The height of sea waves has long been the subject of controversy. In the recent British scientific expedition some instructive data were gathered by a sensitive amend be aronetic capable of recording its extreme rae and fall by an automatur register. With a sea not subjected to an atmosphere of unusual violence, it indicated an elevation of 40 feet from the wave-hase to creat."

ARMOR-PIERCIN(—"The new British steel cruiser Blake is to be armed with handy rapid-firing guns that can penetrate 12 or 15 inches of armor plate."

FOOT-WARMER.—"One of the latest applications of electricity is the making of a floor mat that throws out heat—an electric heater, in fact, in the form of a mat. An excellent device for warming the toes."

AND NOW FOR THE FUTURE

Was Shakespeare Shakespeare? New Findings of Science—by X Rays and Infra-Red Photographs of Paintings—Give Startling Evidence. By Charles Wisner Barrell.

New Express Highway in Pennsylvania Follows Old Railroad Grade.

[Will a Race of Super Men Eventually Evolve? By Henry M. Lewis, Jr.

Research in Noise Sheds New Light on a Number of Everyday Problems. By James A. Baubie.

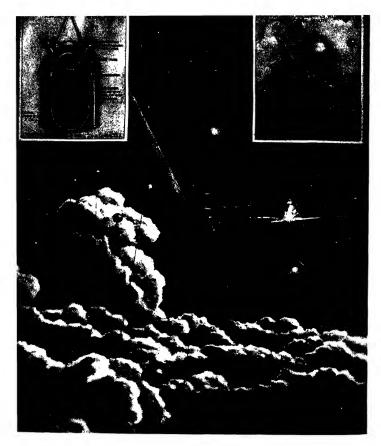




Your friends and neighbors in the telephone company send you best wishes for a Merry Christmas

Through the holidays, as always, we'll be on hand—doing out best to keep the Christmas spirit in telephone service.

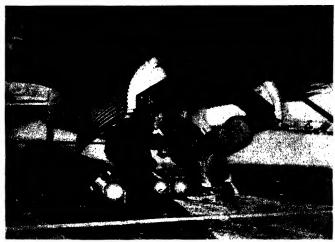
BELL TELEPHONE SYSTLM



BALLOON MINES TO PUT THE AIR OUT OF ACTION

IF ferman bombers appear over London some dark night, they may find above, below, and around them an inescapable aerual mun field consisting of myrasds of small, free bellouns sent to a predetermined height and drifting with the wind Each would support a cannister of high explosure on 40 lect of fine seel wire. Enemy planes would, therefore, face the double danger of fouling their propellers with wire

and contacting the bomb itself. If a wire should catch on a wing, the bomb would be whipped backward to explode against the plane. A time fuse on the bomb allows it to become "alive" only after ade launching and puts it out of action after a given time. This aerial mine has certain dis action after a given time. This aerial mine has certain dis advantages, but it affords, according to H. G. Wells, "the possibility of putting the air out of action whenever we wish it." Invented by Major H. J. Muir, it would have an enormous effect on the morale of enemy raiders. Drawing courtesy The Illustrated London News.



Loading bombs in a U S. bombing plane during recent maneuvers

WILL BOMBS DOMINATE?

ERIAL bombing has become a naval A and military science of dominant importance in offensive warfare. This is attributable mainly to development in aircraft in regard to range, speed, and carrying capacity. Until near the end of the World War in 1918, aerial bombing was a very secondary means of offense compared with aerial machine gunning, which was organized for inter-aerial combat and occasionally used against troops deploying in the open. The airplane, at this time, was not a high-caliber offensive weapon. Today, the aerial bomber has become a supertype of long-range heavy artillery and a significant challenge is now being made to establish its efficiency not only against the strongest land fortifications but also against fleet battle-units and submarines. Recent events indicate that the command of the seas may to some degree be passing over to the nation which can hold command of the air. Should such power emerge, the aerial bomber will have become a primary offensive weapon in general warfare.

Aerial Bomber Has Become Super-Type of Long-Range Heavy Artillery . . . How Bombs Differ in Their Penetrating and Explosive Action

By ARTHUR E. OXLEY, M.A., D.Sc.

Multiple-engined heavy bombers, numbered internationally by thousands, can now carry projectiles, each weighmg a ton or more, over land and sea defenses which are far out of range of the most powerful military or naval guns Such projectiles are equipped with armor-piercing devices for hurling on ships and fortified positions; they explode with a delayed action after penetrating the objective Other projectiles are equipped so as to produce a "scatter" effect over the widest range possible; they are designed to cause the greatest devastation in troop concentrations deploying in the open or on unsheltered civilian populations. Such

projectiles explode instantaneously on contact with the objective.

High-explosive bombs may be classifed in two general groups according to their penetrating and delayed explosive actions or their non-penetrating and instantaneous explosive actions. The first has a relatively thin shell and a penetrating nose-cap of solid steel; the second has a thick shell for more deviasting ingeneration effect and a blunter nose to counteract penetration. There are many types of bomb in each classification and those illustrated diagrammatically in Figures 1 and 2 are intended merely as examples to indicate the general difference in the two classes.

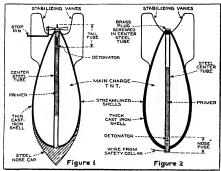


Figure 1 shows general details of a penetrating type of bomb, in which the fuse action is delayed Figure 2 illustrates a nose fuse type for instantaneous action

The type of fuse used in the bomb shown in Figure 1 is a delay fuse inserted in the tail of the bomb; that in Figure 2 is an instantaneous fuse fitted into the the nose of the bomb. (A delay fuse may also be fitted into the nose of a bomb but its construction must be different from the type shown.)

THE delayed action bomb penetrates and is used in attacks on ships or on towns where the structures are several stories high and are more or less strongly reinforced. Such a bomb, if dropped from a height of 10,000 feet, strikes the object at about 800 feet per secondmore than 500 miles an hour. On striking, the bomb does not explode immediately. It penetrates the roof and may pass through three or four floors before the fuse explodes it. The reason for this delayed action is shown in Figure 3. a diagram of one type of tailfuse. The bomb can explode only when the striker-pin punctures the detonator cap. When the bomb is fused, the striker pin is held away from the cap by a collar to which is attached a pair of vanes. While the bomb is in its carrier on the airplane, these vanes are prevented from rotating by a stop pin fixed to the carrier (Figure 1). As soon as the bomb is released, the vanes rotate, owing to the rush of air past the bomb. After the bomb has fallen about 100 feet below the plane, the vanes fly off the screw-spindle. To prevent the strikerpin from prematurely piercing the detonator while the bomb is in the air, the striker rides on a coiled spring as the bomb falls. On impact, the bomb is slowed considerably while the plunger carrying the striker has nothing to stop it but the resistance of the spring. The merta of the striker therefore compresses the spring and, in a small fraction of a second after impact of the bomb, the pun pierces detonator and the bomb explodes. This small delayed action is sufficient, however, to allow the bomb, because of its terrific speed and penetrating cap, to pass 20 to 50 feet made a building, according to the nature of its construction, before exploson takes place. Thus the structure collapses from the pressure of the confined blast.

In addition to the objectives already cited, deep trenches and air-raid shelters may be successfully attacked by bombs so fused.

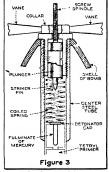
The instantaneous fuse used in the bomb shown in Figure 2 is designed to cause the greatest possible spread of the bomb fragments, by the explosive blast, so over the surface of the terrain attacked, the thick shell is shattered into chunks of metal which sweep over a wide area as the high-explosive is defonated. A type of nose fuse used for such a purpose is shown in Figure 4. The instantaneous explosion resulting is far more devestating to exposed personnel than would be the delayed explosion described above.

The nose fuse shown has no spring, Instead, a plunger is held securely in position by a copper pin, about 1/8 of an mch thick, which passes through the plunger and the walls of the fuse. While the bomb is in its carrier on the airplane, the fuse is kept "dead" by a safety collar which is slotted and inserted between the body of the fuse and a pressure plate. This collar is attached to the bomb carrier (see Figure 2) and is a secure protection against premature detonation even should the bomber crash efforts of the protection against premature detonation even should the bomber crash

on taking off. As the bomb is released, the safety collar is withdrawn. On impact, the pressure plate is arrested. The shock which it thus receives can be transferred to the detonator only through breakage of the copper pin which is incapable of withstanding the tremendous momentum of the whole bomb. The result is that the copper pin is instantaneously sheared off and within less than a hundredth of a second the striker pin pierces the detonator which causes explosion. Owing to the almost instantaneous action of this fuse, the explosion makes only a very small crater -perhaps one to two feet deep on average ground for a bomb weighing 100 pounds. Under similar conditions the same bomb, fitted with a tail fuse, would make a crater about five to six feet deep. Figures 5 and 6 show this difference, With a tail fuse, the bomb is almost buried in the ground on explosion and the blast is localized With a nose fuse, the bomb is almost entirely above ground and its blast is wide-spread.

WHEN bombing from low altitudes, as was done over the countryside in Poland, an additional slow time-fuse must be inserted between the striker mechanism and the detonator. On release the bomb travels forward with the same velocity as the autipliane and the additional delay of at least several seconds, given by the time fuse, allows the bomber to get clear of the danger zone before detonation takes, place.

The main filling charge of modern high-explosive bombs is relatively insensitive. Tri-nitro-toluene (T.N.T.) and various mixtures of this with ammonium nitrate, itself an explosive, are the usual fillers. The mixtures are known as "amato". Sometimes a small

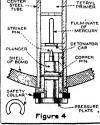


Details of a tail fuse

percentage of powdered aluminum is included in a filler called "ammonal" which has a higher temperature of detonation. Without the use of a detonator none of these explosives will function even on impact of the bomb from several thousand feet. Even the detonator, containing a few grains of fulminate of mercury, which explodes violently on shock, is not a certain guarantee of detonating the main filling charge. It is customary, therefore, to employ a primer consisting of an explosive more sensitive than T.N.T. but less so than fulminate of mercury, to boost the detonator and effect the complete detonation of the filler. In serial bombs, this primer is charged with (tetra-nitro-methyl-aniline), "tetryl which, like T.NT, is a dye-works byproduct. The general manner of assembly of detonator, primer, and filler is shown in Figures 1 and 2

FOR modern incendiary bombs, a most effective filler is thermit. This consists of a mixture of powdered aluminum and magnetic oxide of iron, and is commonly used in welding. When it is fired through a magnesium primer which in turn is ignited by a phosphorus coated friction strip, a temperature of from 2300 to 2500 degrees, centigrade, results-a temperature which easily melts steel Thermit does not depend upon a surrounding atmosphere of air for its action-the oxygen in the iron oxide provides this, uniting rapidly with the aluminum and causing the tremendous rise in temperature The mixture will burn under water, boiling it fiercely. Water is uscless to extinguish the whitehot slag-it merely passes into scalding steam. Sand is best for localizing the incendiary action

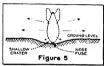
Modern incendiary bombs are very small: about six inches long and threequarters of an inch in diameter. They are provided with heavy penetrating iron nose caps and small fixed tail vanes. Containers, each filled with several hun-



Details of a nose fuse

dred bombs, are discharged as units. On their downward flight they scatter, since they are poorly streamlined, and cover a wide area of the objective. Hundreds of ferce small fires are thereby stated, and any attempts to control the general conflagration are made extremely difficult owing to the numerous scattered outbreaks. If such an incendary raid is immediately followed up by a raid with high-explosive bombs, and possibly also a gas attack, no fire personnel or equipment can cope with

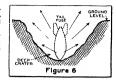
Among bombs used in gas attacks, the most effective are those filled with "mustard gas," which is a liquid. When burst by a small powder charge, the heavy high diffuses into the ground and, for days after the attack, is dangerous to anyone in the locality. Where the temperature rives locally, unexpected vapors emerge and may descend into the deepest dugouts and shelters. This wapor acts slowly on the eyes and lungs it has practically no smell and long it has practically no smell and long after a raid unsuspecting persons who



A bomb fused at the nose explodes on contact, spreading a wide blast

chance to remove their gas-masks—as they must do sooner or later, either for nourishment or comfort-may be attacked without warning. Some hours later blurred eyes, lump bodies, and severely blatered skins show the results. This gas causes only a low mor tality but it is highly efficient in putting personnel out of action.

As the war develops, it is possible to make only a guess as to the limits to which chemistry and physics will be applied as aids to aerial "frightfulness." Rumors of the use of super-high-explosives spread 'round the world during the later aerial bombardments in northern Spain. Liquid oxygen was suspected as the component Cylinders of cellulosic material when dipped in liquid oxygen become virtually packages of dynamite and when freshly prepared have enormous detonating power But other attendant circumstances, particularly those relating to the high vulnerability of such explosives to shell and even bullet fire and to the evanescent power of the charge-due to continuous and unpreventable evaporation of the liquid oxygen-would seem to lessen the likelihood that such liquid-oxygen matrices could be of real military effectiveness. True may be the report



Penetrating deeply, the blast of a tail-fused bomb is more localized

that the explosive used was "obtained from the air"—but so are the ammonia ingredients used in "amatol" and "ammonal" high explosives obtained by the nitrogen fixation process.

There is also the possibility that concentrated effort is being made to seek a practical application of what has been called the greatest scientific discovery of the year—the detonation of atomic energy as exemplified in the selfcatalyzing fission of uranium and other substances, the neutron bombardment.

LAST, we cannot completely ignore the possibilities of biology. Reports are available that much experimental work has been done on the possibility of employing bacteria as a novel kind of "ammunition." In this connection, Wickham Steed has called attention to the activities of the aerial offense section reported in Luft-Gas-Angriff of the Berlin War Office. In 1938, General Chu Teh reported to the League of Nations that the Japanese had used bacteria in four central China provinces. These try-outs may have shown either the present impracticability or the dangers which attend such desperate means, but modern civilization cannot entirely shut its eyes to the possibilities of future research in this field. The biological view indicates that the effective dissemination of a bacteriological fog of typhoid, anthrax, spotted fever, or plague would have to be carefully synchronized with exacting conditions of temperature and humidity to insure survival of the germs. The bacterial "bomb" apparently consists of a glass container filled with a prescribed culture which is floated by parachute control over areas far in the rear of enemy lines, a mechanical release being employed to release the contents either in the air or on ground contact. The available reports also indicate the "conscription" of infected vermin.

If such monstrous methods should ever become practicable at appears that the only means of defense both for the attacker and attacked would be an elaborate organization of all resources of prophylaxs. Probably a mere knowledge of the power of retaliatory measures, even should such attacks prove practicable, will be an adequate deterrent against such attempts.

ALL FOR ONE AND ONE FOR ALL

T is customary to think of that large group of companies which provides motor transportation for America. and for much of the rest of the world, as units in a number of industries—automotive, aviation, oil, tires, parts and accessories, and so on. Actually, this entire group is one inter-related, interdependent industry, the problems and progress of which are inseparably linked Nothing illustrates this so well as their co-operative research activities. It is doubtful whether anything in American industrial life during the past ten years has been more significant than the freedom with which research men in this group have exchanged ideas and co-

operated in experimental projects. The fruits of this research have had a far-reaching effect. Better cars at lower prices, better gasolines at lower prices, better tires, airplanes. trucks, tractors, stationary engines, motorboats, and other products made by these companies have been in such demand in America that this closely associated group has grown to a point where it now employs the full-time services of between six and seven million people; furn ishes bread and butter for a sixth of the nation directly, and a considerably larger percentage if all those indirectly employed are considered Almost every person, young and old, has benefited to a greater or lesser degree through faster, safer, more comfortable transportation

Much has been written about modern research methods, but most of it remains incomprehensible to the average layman. When John Q Public makes what he imagines is a firel econ omy test, he tries out three or four brands of gasoline and, the the basis of the most casual

draing, decides that one is better than the others Of course, such a "test" has no scientific basis. When research mentackle such a problem, they eliminate take into account every variable, such as the air pressure and diameter of each tire, himidily, temperature, and barometer readings for the day, the condition of the road; the velocity and angle of the wind, and the manner of arceleration and deceleration

Even one variable, the manner of driving, can make as much as 100 percent difference in miles per gallon. In a recent experiment in Detroit, two cars of Research in Motor Industry . . . Co-operation and Exchange of Ideas, Findings . . . Has Resulted In Numerous Significant Developments

By J. J. FREY
Engineer in Charge of Technical Salas Division

the same make and model, both just of the production line, were driven in city traffic over the same route. One driver was told to "step on it" at green lightand to drive as fast as the law allowed until he had to put on his brakes for the next stop light. The other was told to accelerate and decelerate gradually, to make as little use of the brakes as nos



After this laboratory test of an engine, on which is mounted a V-belt driven supercharger, the engine will be installed in a truck for extensive road tests

sible The first car used twice as much gasoline as the second in covering the same distance!

Let us look, then, as an example, at how one group of research engineers made a fuel economy test First, they searched for an absolutely level place where they could run cars at steady speeds and at pre-determined varying speeds without interference. This they found in the middle of the Mojave Desert in California—the tuble-flat bed of a dry lake. Next they devised an instrument which would measure and record the velocity and direction of the

wind at all times, a fifth wheel, which would overcome the variable of tire slip page, was installed and attached to a recording device to show exactly the distance traveled over land as compared with the distance traveled through air, asmeasured by an anemometer. Fuel wasfed into the carbureter through graduated gages which measured the gasoline

in cubic centimeters. Humidity and temperature records were calculated at all times. The tests were run over and over in order to average the errors which the engineers knew would still creepinto the calculations. Altogether, the work covered a period of months and cost several thousand dollars.

7 OU may well ask who went Y OU may well as did it prove The answer goes to the very heart and spirit of the group which furnishes the vehicles, the tires, the gasolines, the parts and accessories, right down to the last gadget used in motor transportation Fuel economy is the concern of many groups and literally hundreds of companies. The company which made this economy test manufactures tetraethyl lead, which is used by oil companies to im prove anti-knock quality of their gasolines. But the data

obtained were of interest to dozens of companies, showing, as they did, pertinent figures for what engineers call optimum compression ratios, carbureter settings and fuel anti-knock requirements of particular types of engines.

Although several companies often take part in one co-operative research program. I must, for obvious reasons. confine examples to the part of such projects about which I have personal knowledge and which concern, as above, the research activities of a company that manufactures anti-knock compounds for gasoline.

Some of the most interesting, and at

times, most difficult parts of research or projects are the development of devices properly of the development of devices opened of instruments to measure pertinent variables. No laboratory can infunction without instruments and, strange as it may seem, very few of the migration of the purchased. When such instruments are needed, there is usually only one way to work of the problem—uvent them. A few properties of the problem—uvent them.

In one of our research projects, we wished to measure the air-fuel ratio in each of the individual cylinders of an engine. No instrument for such measurement urement existed, or if it did, we could not find it. So our engineers devised a set-up which enabled us to trap a sample of the combustion products of each cylinder and analyze them. In the same project we wished to find out the exact instant when each cylinder fired. The instrument finally worked out recorded the ignition timing on cincina film Sometimes a research project becomes so involved that the engine being studied is converted, for all intents and purposes. into an "instrument." Such an "instrument" looks like an ordinary heavy-duty truck until you get into the cab or lift the hood. The average truck driver would find gages, dials and gadgets he had never seen before Under the hood he would find that each set of three cylinders had its own fuel system, and many other modifications This "instrument" took several months to assemble and build and cost over \$10,000, but it proved immensely valuable in tests where it was necessary to eliminate the variables that always must occur when the performance of one truck engine is compared with another

7ITH proper instruments, technically able and intelligently farsighted research workers, given sufficient time and resources, accomplish feats that in the aggregate become gigantic For example, 15 years ago, the engine of the average American automobile had a displacement of 252 cubic inches and could develop 59 horsepower. The average 1940 automobile engine has a displacement of 255 cubic inches. almost identical with the engine of 15 years ago, but it can develop 106 horsepower. Thus we see that in the short space of time that anti-knock compounds for gasoline have been available, the horsepower developed by the average American automobile has been increased over 80 percent, while its weight has remained approximately the same. A large part of the increase in power has been gained by increasing the pressure on the gasoline vapor in the cylinders before it is burned, which, in effect, squeezes more power out of each drop of gasoline. This is where the anti-knock quality of gasoline becomes important, for higher



Cathode-ray oscillograph for testing ignition system characteristics, and apparatus to determine spark plug insulator resistance and minimum firing current

anti-knock quality is required if gasoline is to burn smoothly under the stress of great heat and pressure inside a cylin der

Seems to be a simple matter, doesn't it! Use gasoline of higher anti-knock quality, squeeze it a little righter in the combustion chamber by mercasing the compression ratio and picsto, you get more power and better economy Unfor tunately, it was not as easy as that A multitude of problems had to be solved before this happy result was achieved It is more or less a truism in research that when a change is introduced to solve one problem five or six other problems may be created That was what hap pened when compression ratios were moved up Research and experience showed that the compression ratio which may be used with a given fuel is influenced by many variables including engine design, cylinder size, materials of construction, carbonization rusting and liming engine speed, jacket temperature, mixture ratio, mixture tein perature, volumetric efficiency and ignition tinging

Ingineers spent years studying these variables as well as the relation of compression ratio to bearing pressures valves, spark plugs, and so on Hundreds of tests were run on high nedium, and low compression engines, both in the laboratory and on the road. Literally thousands of adjustments and re-adjust ments were made

all this work eventually led to the universal utilization of higher compression pressures and higher compression pressures and higher compression ratios in passenger car engines. The average compression pressure in the 1931 automobile was between 90 and 100 pounds per squares inch. Today the average is between 140 and 150 pounds Average compression ratio in passenger automobiles in 1925 was 4.5 to 1. By 1931 the average had risen to 5.25 to 1

Today at is 6.28 to 1. Optional compression ratios micendership higher. One manufacturer has available a cylinder bend group 7.45 to 1 ratio. And tests have been run in the laboratory on enciences with compression ratios as high as 11 to 1. The net result, as pointed out above, has been more power and better economy with very little increase in encience with compression ratio or produced to the property of the produced of the

BUTs such results would not have been possible had not the 'oll companies kept in step with the march of progress by improving the anti-knock quality of gasolines year after year. Butter cracking processes, polymerization, selection of crudes, blending, and the addition of crudes, blending, and the addition of trate-thy lead have provided the fine fuels at low out which have justified car manufacturers in designing popular-proced cars which reach ever higher plateaus in engine efficiency.

And this parade of progress has not stopped Supercharging for the average car may be the next step which automotive engineers take to squeeze more power out of better gasolines, and so our research workers for the past several years have been experimenting with the possibilities and problems of supercharging. In one test, a stock eightdoubled its power output after being eylinder passenger car engine almost supercharged The engine had an orig inal compression ratio of approximately 51/2 to 1 and developed 82 horsepower at 4000 r.p m. using fuel with an anti-knock quality of 78 octane number. After it was supercharged with an intake manifold pressure equal to 10 inches of mercury, it developed 160 horsepower, using gasoline with an anti-knock quality of 90 octane number. To carry this test further and to determine what advantage supercharging could give to this



Car with anemometer and fifth wheel speedometer. The former determines wind direction, velocity; the latter gives an accurate speed reading. At right Instruments within the car for use in conjunction with those shown above

engine without nequiring a fuel of greater octaine number than that onginally used, the compression ratio was lowered to 4.25 to 1. Using 78 octaine fuel again, but supercharged to 10 inches of mercury, the engine developed 63 percent more horsepower than it had with the higher compression ratio on the same fuel.

Thus supercharging, which simply means forcing more an and fuel vapor into the engine by putting greater-than atmospheric pressure on the intake mani fold, seems to promise more of the same kind of improvement that was effected by increasing compression ratios But there are still a number of problems for research workers to solve before all of the hoped-for gains in efficiency can be realized. For example, in the tests in our laboratories we could put any pressure we wished on the intake manifold at any speed because the engine was on a stationary mounting, taking its air from a tank where constant pressure could be maintained The problem of achieving equal control with a blower driven by the engine being supercharged is quite another matter. Other laboratories in the research departments of automobile companies, and manufacturers of superchargers, are working on this problem now We are co-operating with them. giving them the results of our work and they giving us the results of theirs

But what will be the effect of such great increases in power on other parts of the engine? Will present engine steels, stand the gaff? Take valve steels, for example. Fifteen years ago, cast iron was used for exhaust valve heads in mans engines Increases in compression prasure and more revolutions per minute made it obsolete. Sitch-rome steel heeame the standard. Today, with still furtiler demands, Stelline-faced valves have comto prominence, and with all the heat and pressure of modern high-speed operation they will open and close (and make a tight seal) 10 to 20 times a second for hours on end while you buzz merrity along without ever a thought of 1,300,000 jobs each valve is sesigned to do in your engine every thousand miles

What about spark plugs? Will supercharged engines call for still further improvements here? A spark plug that wasatisfactory in the car of 1925 would not last 15 minutes in a 1940 car running at wide open throttle Years of experimentation and testing have given the answer to the question of how to make them in satisfactory for today's car. What about to tomorrow? Only research, trial and error, and trial again can supply the

WITH this past experience in mind, it is easier to understand why super-charging is today of interest to many companies and many research workers and why they swap knowledge and conserve time and money by cooperafive work. When you start changing the character to fineresic gasoline engine, or start changing the character of Jenerosic gasoline of its gasoline, you interest everyone in a group of industries employing literally billions of dollars.

Even when the finished product is in the hands of the ultimate consumer. many organizations in the vast automotive transport group lend a willing hand in solving problems in operation that may arise. A typical example with which I am familiar was a bad case of what the trade calls "tail pipe halitosis" experi enced by a large city bus company. The situation reached a climax in November. 1936, when civic organizations de scended on the company and demanded that something be done to stop the fumes of acrid smoke pouring from the exhaust One of our service engineers, a veteran of innumerable tussles with hus and truck problems, offered his services. The bus company furnished him an engine of the same model used in the buses and it was set up in our Detroit laboratory. After several weeks of experiments and tests, he worked out a procedure for correcting the trouble and presented it to the bus company. The officials tried at out on ten buses, found that it worked and eventually changed over their entire flert. His recommendations—moreosed untake manifold temperatures, changes in carbureter characteristics, including leaner offle mix-acteristics, including leaner offle mix-



tures—have been adopted by other bus companies and today are standard practice in meeting the condition known as "tail pine halitosis"

Another field in which the continuing efforts of research have led to tangible results is power farming. Five years ago. all tractors were equipped with "compromise" engines-that is, they were designed with low-compression motors to burn kerosene, distillate, or gasoline But farmers who burned gasoline in their tractors got only part of the potential power in the fuel. Why not build tractors with high compression, automobile-type engines capable of using gasoline efficiently. This would give the farmer something he wanted. Tractor engineers who held this belief found ready assistance in our engineering laboratories. The advantages of high-compression tractors were determined by the laboratories and explained to the farmers and tractor dealers. Today nearly all tractor manufacturers make high-compression tractors.

As the new 1940 cars go on the market there are improvements and refinements not available on cars of previous years. Three changes represent a cumulative total of thousands of hours of recease labor in a hundred different laboratories.

The same impelling force and relentless research which have given us today's engines and vehicles will push on to discover and utilize better principles and materials for the motor transportation of the future.

OUR POINT OF VIEW

No Vigilantes

TIMES of national stress alwaysbring with them curious and often dangerous personal reactions. Mass hysteria, fostered by ill-founded rumors and frequently by malicious gossup, was the cause of many a vicious outburst during World War I. Spy sares set neighbor against neighbor, created suspicions that often had no more foundation in fact than a foreign-sounding name.

With present unsettled conditions pointing toward a future that cannot be predicted, it is comforting to know that our national security has been placed in the capable hands of the Federal Bureau of Investigation This organization, with the co-operation of all law-enforcing agencies throughout the nation, should certainly be able to cope quickly and effectively with internal affairs that might have disastrous effects of permitted to get out of hand.

Speaking of this latest job of the F. B I., Director J. Edgar Hoover recently sounded a warning that, heeded, will assist greatly in keeping the United States on a level keel during troublous omes "In the wave of patriotism that is rising in the country," said Mr Houver, "there lies the danger of overrealous groups or individuals engaging in acts which are distinctly un-American in method, no matter how patriotic in aim. We need no vigilantes in this situation The vigilante method is disunctly contrary to American ideals of justice. The Federal Bureau of Investigation has been called upon to investigate all matters relating to espionage, sabotage, and violations of the Neutrality Regulations. In turn, the Federal Bureau of Investigation has requested co-operation of all law enforcement officers in the United States.

"This combined attack by Federat and State forces should be sufficient so far as investigation and prosecution are concerned." Mr. Hower continued. "Beyond the efforts of these law enforcement agencies there is a need, of course, for the individual co-operation of all suncer and carnest Americans. This co-operation should be limited, however, to passing on to the proper officials all questionable facts or rumors which may come one's way. An alert public is the best defense against traitorous or imminated conduct. Let us be realistic and practical. but always calm in our judgment between the real and unreal."

Thus each individual citizen is squarely faced with his own share of the problem of controlling traitorous acts, yet adequately warned against actions that might not only hamper the wheels of justice but even render them momentally ineffective—A. P. P.

Modern Pioneers

NOT so many years ago this nation celebrated 150 years of existence by the Sesqui-Centennial Exposition Next year it would be fitting if we should have another sesqui-centennial celebration, one that would mark one of the few extremely significant milestones in our lustory the founding of the American patent system. Our progress has licen keyed largely to that system and the incentive which it has given to individuals to originate, develop, and improve those brain-children that have made this country the greatest industrial nation on earth. Had it not been for the granting of patents and the profits therefrom our neople would not now have the most advanced civilization ever known, nor enjoy the greatest number of conveniences, coinforts, and luxuries. we would lahor longer hours and have much less leisure time. Our patent system has been, indeed an important stimulus to invention, research, and in dustrial progress

It was with the thought that the American people should understand clearly the dependence of the nation on a sound patent system one that is not being changed constantly at the whim of would-be economists, reformers and malcontents-that this important anuversary is to be observed in 1940. The Modern Pioneers plan to mark the year by several interesting programs, the principal one of which will be the presentation of a number of awards to outstanding inventors and research workers Manufacturers and responsible executives or members of trade associations and scientific and engineering organizations are being invited to enter nominees for these honors. (Entry blanks may be obtained from Modern Pioneers, 14 West 49th Street, New York Closing date: December 1, 1939) Local dinners will honor selected local Modern Pioncers, and some time in February a national dinner, broadcast over a national radio hook-up, will honor a number of the country's outstanding Modern Pioneers.

That the whole program will succeed m its purpose seems saured by consideration of the Award Committee. It is composed of: Karl T. Compton, of M.I.T., Chairman; Forest R. Moulton, of the A.A.A.S.; George B. Pegram, of Columbia University; John T. Tate of the University of Minnesota, Edward R. Weidlein, of Mellon Institute; and Frank C. Whitmore, of Pennsylvania State College

We wish the organization the great success it richly deserves —O D. M

Not Poison

"THEY who get spanked" ninglit well have been the title of a brief item lost to the general reader by its inclusion on our Legal High-Lights page last month. It is here resurrected for the same non-legal reader because of its stat lument.

It seems that the Federal Trade Comterculating "from time to time") as to the injurious effects resulting from the total time to the season of the total time to the season of the publisher of the rumor "traces," charge ing that he deceives the public. To us this is a masteripace of understatement

This bare-faced campaign to instill an awful fear in the mind of the public has been going on for many years-not just from time to time. It has been fanatic Why no one knows. It has been insidious, powerful in its effect It has offered such a specious brand of "proof" that food cooked in aluminum acts as a slow poison or causes cancer or both that believers have carried on the cycl work by word of mouth. And the believers have not all been unintelligent, simply unwise. A cultured lady ouce told this writer of a trained nurse in a great city hospital (of all places!) who was suffering from a serious case of aluminum-cooking-utensil poisoning!

The fight against this foul campaign of fear has also gone on for years Scientific American has been in the thick of tlus fight, has patiently ex plained over and over that aluminum cooking utensils can have no injurious effects on those eating food cooken in then: In unequivocal terms, this maga zine has branded rumors to the contrary as malicious and entirely without foundation. We repeat the accusation. The American Medical Association, Mellon Institute, Government bureaus, and others have all done their share of the fightuig against the rumor, have done their utmost to scotch it. Yet even now. with the Federal Trade Commission lined up against the fanatics, some people will probably keep talking of the dangers of aluminum-cooked food. But then, they're probably born pessimists and think they have every ailment ever mentioned by Sister Sue and Grandpap and Aunt Het, anyway!-F. D. M.

WHAT'S INSIDE THE STARS?

THE recent Colloquium on Astrophysics, at Paris, under the auspices of the Foundation Singer-Polignac at which the writer had the good fortune to be present, will have a place in the memory of its participants something like that of the great international conference of the Solar Union at Bonn in 1913shining the more hrightly by contrast with the tragic days which followed. Unlike the earlier meeting, this was a small affair with only 16 regular delegates. and a scant dozen of other invited guests; but it was truly international. Seven countries were represented among the delegates, counting by present residence

-France, Belgium, Denmark, Sweden. England, Canada. and the United States Counting by country of birth, four more are to be added—Holland, Germany. Russia. and India — represented by astronomers of distinction, all of whom are now living in the United States!

The sessions—held in an excellent room provided by the Collège de France—gave much more time for the consideration of individual topics than is practicable at the larger congresses. One, or at most, two of the invited papers were presented at a session; the speaker had 40 minutes or so to present his conclusions, and almost as much time was often spent in animated and profitable discussion.

The problem of language-always more or less difficult at a truly international gathering-was very successfully solved All the speakers found it easy to present their views either in English or French, and their remarks were translated into the other language, sentence by sentence, as they went along, by a very competent secretary After a few minutes' experience, this proved remarkably simple; and, though of course it took time, it did not interfere with the free flow of thought and expression, even in active discussion (and the discussions were active) --- as many as ten members sometimes commenting on a single paper The scheme worked so well, indeed, that it may be commended in other cases where the language problem has to be met

The Colloquium confined itself to two subjects, more closely related than appears at first mention; namely, the novae and the white dwarfs. All the delegates spoke with authority in one or another part of this fairly extensive field.

Lundmark discussed the parallaxes and absolute brightness of the novae; Stratton, the evolution of absorption bands in their spectra; Edlen, the idenMost of Our Present Knowledge of the Composition of the Stars Concerns Only their Atmospheres . . . Now the Analytical Boring Machine Digs Deeper

By HENRY NORRIS RUSSELL, Ph.D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University Research Associate of the Moint Wilson Observatory of the Carnegie Institution of Washington

infication of previously unknown lines and Mrs Gaposchkin a spectrophotometric study of the bright bands and continuous background

Beals considered the relations of novac to Wolf-Rayet stars, P Cygni stars, and stars with spectra like Alpha Cygni, and Gaposichin their relations to the SS Cygni variables

Swings spoke of the physical problems of the atmospheres of novae and similar stars, Strömgren of theories of their internal constitution, and Baade of the amazingly luminous supernovae

Turning from the hugest of the stars to the tunest, Kuper described the white towarfs and other abnormally flant stars, announcing the discovery of many new ones and discovery of the stars of the star of the st

O UR less technical readers may be asked to excuse this condensed list of papers. Every one of them contained things which can be presented in non-technical language, and are of general interest To describe them all would fill many pages like these At present, it may lie well to follow a long-established rule of these columns, and speak of work which has already been published, in part at least, in professional ournals.

The question of the composition of the great internal mass of a ster might be supposed to be inherently unanswerable. The spectroscope gives us a wealth of information about the atmospheres of information about the atmospheres of the stars, and hose established convincing evidence that they are, in general, very similar among themselves in composition (though not in temperature or pressure) and much like the Earth, except for a vastly greater abundance of hydrogen and helium

But the atmosphere of a star—which forms less than the outermost billionth part of us mass—may not be a fair sample of the whole. We can only "get deeper" (to use Eddington's phrase) by an "analytical boring machine." For an

ordinary star, the process is in outline

The central temperature of a star depends on its mass and radius, on the average weight of one of the free par ticles in its interior (atoms, electrons, and so on) and on the "model" on which it is built -that is, the way in which the density increases toward the center. The latter effect is found to be remarkably small-it takes an increase of density at the center to more than a hundred times the general average to get a central temperature twice that for a star of uniform density The average "molecular" weight is more important, for the temperature is proportional to it. At the center of a star the atoms are knocked all to pieces Hydrogen (weight 1) goes into two pieces (with an average weight of 1/2); helium, weight 4, into three (average 1 1/3); oxygen divides a weight of 16 among 9 pieces; iron one of 56 among 27 fragments (or under actual conditions a few less). For all sorts of atoms. except hydrogen and helium, the average weight of one of the dissociated particles comes out close to 2 (on the chemists' familiar scale); for helium it is two thirds as great as this and for hydrogen only a quarter

Hence, the more hydrogen there is inside a star of a given mass, size, and build, the cooler the star will be inside. The rate at which heat leaks out to the surface will be correspondingly smaller, and the star will shine less brightly Helium has a similar effect, but to a much smaller degree.

The analytical theory has been fully worked out-first by Eddington, and in more detail by Strömgren—and it is found that a sar containing no hydrogen should be about 300 tumes as bright but containing about 80 percent of hydrogen by weight. For almost pure hydrogen the true theoretical brightness rises again; but this does not concern us here.) The brightness of a star with a gwen hydrogen content can be calculated from pure theory—assuming a goed average "model"—and it is found

that such stars as Sirius, Capella, and the Sun are all much fainter than calculated for no hydrogen. Theory and observation agree for a hydrogen content of about 35 percent for all three stars. (This is hy weight; by number, the light hydrogen atoms form a large majority.)

Reasonable change in the assumed density-model might alter the calculated abundance of hydrogen by a few percent but would not greatly modify it.

Most of the stars for which the calculations can be made come out of about the same composition. There are a few exceptions For example, Zeta Herculis has very nearly the Sun's mass, twice its diameter, and four times its brightness—which indicates a hydrogen content of about 15 percent.

This method, applicable to ordinary stars, fails entirely for the white dwarfs, But, strangely enough, the hydrogen percentage in these can be found in an entirely different way. In a white dwarf the free electrons are degenerate-they are sammed together as closly as the fundamental quantum laws permit. Under these conditions, the pressure varies as the 5/3 power of the number of electrons per cubic centimeter. Given this law, and the average mass of matter per free electron, we can work out all the properties of the body, if we know the total mass, finding its radius, density and so on. The actual white dwarfs, being visible, and therefore hot on the surface, cannot be entirely degenerate, but there are good reasons for concluding that they are actually bigger than this theoretical limit by only a small percentage.

Now for the companion of Sirius-the most famous of the white dwarfs-observations have been made of the "Einstein shift" of the spectral lines predicted by the general theory of relativity. For any star, this shift is proportional to M/R (where M is the mass and R the radius). According to the theory just described, the shift, E, is given by the equation $E = C M^{4/3} m^{5/3}$ where m is the average mass per free electron, and C is a constant which can be accurately calculated. Now for a hydrogen atom m = 1, there being one proton per electron. For helium m = 2 (mass 4, 2 electrons) and for heavier atoms it is nearly the same. For a white dwarf star of a given mass, and composed entirely of hydrogen, the Einstein shift should be less than one third as great as for one made up exclusively of heavier atoms.

For the companion of Sirius, the observed shift is intermediate between the calculated values for these two cases, and indicates a hydrogen content of about 35 percent.

There is unfortunately no other white dwarf for which our present data permit a similar test. There is one (40 Eridan) B) for which we know the mass, but the Einstein shift has not been measured, and estimates of the radius from the spectral type are precarious.

At this point a complication must be mentioned. The question, what equations are to be used for a degenerate gas when the velocities of the electrons become comparable with that of light, is still vigorously under debate. Sir Arthur Ed-



Atop the physics building at the University of Minnesota this 12ton dome for a 10½-inch telescope is insulated against temperature changes by two-inch slabs of Celotex laid between Tacetton members

dington maintains that the same formula should be employed, almost all other physicists agree in adopting a different one. The discussion, which is intensely technical, leads to the very frontiers of fundamental theory, and neither party has yet convinced the other.

Fortunately for our present interests. Chandraschar, who has worked out the consequences of the alternative theory with great analytical skill, finds that it, tion, when applied to the companion of Sirius, leads to a considerable abundance of hydrogen. This conclusion appears therefore to be independent of the theoretical controversy.

But, if there is still about as much hydrogen in Sirius B (the faint companion) as in Sirius A (bright) the astrophysical consequences are important.

According to Bethe's theory, the stars derive their energy by converting hydrogen into helium, and it is only after the hydrogen is almost absolutely exhausted that they have any chance of contracting into the white-dwarf state. The existence of a single white dwarf contain

ing abundant hydrogen appears therefore to be a grave objection to the theory.

Eddington has, however, suggested a way out. In Bethe's theory hydrogen is turned into helium, not directly, but by the action of catalysts—carbon and nitrogen—which are regenerated at the end of the cycle, and so used over and over again.

Suppose, however, that in each cycle a small portion of the catalysts is used up. Then, though the process would be repeated many tunes, it could not continue mediantely. The catalysts might be used up before the hydrogen, the formation of helium, and the liberation of sub-stome energy, would substantially cease, and the star might shrink unto a white dwarf with a good deal of its hydrogen left—plenty of fuel, but mothing to hur ut with.

Those who have followed our recent presentation of Bethe's theory, will realize that only a very small change in it is required He concludes that the N18 nucleus may meet two fates N" + H1 = $C^{ii} + He^{i}$ and $N^{is} + H^{i} = O^{ii} + hv$. In the first case, carbon is regenerated: in the second, the very stable nucleus of common oxygen is formed, while the energy hy is liberated Now neither of these reactions has yet been observed in the laboratory (at least, when the writer last had access to scientific literature) Bethe, from rather general considerations, concludes that the first is many thousands of times more likely to happen than the second-in which case a small amount of carbon would catalyze the transformation of a very large amount of hydrogen But, if the second reaction had a probability a few percent as great as the first, the carbon and nitrogen might be used up before the hydrogen

UNTIL more is known, by observation or by the advance of nuclear theory, about these questions, the stellar problem must remain open.

One difficulty, however, vanishes. It was very hard to see how Strius B, which shines feebly and is working at a low rate, could have used up its hydrogen before Strius A, which is working far faster The present answer appears to be simple it hasn't

There are other possibilities. Eddingtion calculates that, in the intermediate stage of contraction between an ordinary star and a white dwarf, a star would reach its greatest luminosity and its highest central temperature when it had shrunk to only about twice its final radius. Such a star would appear intensely blue-white, and have a central temperature of 150,000,000 degrees or more, and a very high density. Mether, under such extreme conditions, some of the heavier elements could be built up, is another problem for the nuclear physisist — Pordeaux, France, September 11.

Is Light Slowing Down?

THE third letter of the alphabet, c.

Is harmless enough in the normal course of things, but in the hands of scientists it has become a hook on which can be said to hang the whole of modern physical science. For scientists have chosen this little letter to represent one of the most important constants of the universe—the velocity of light.

In almost every fundamental physical equation, whether it be concerned with the structure of the atom or the rate of expansion of the universe, whether it deals with the energy of X rays or the mass of a rapidly moving body, the letter c will occur. Way back in the middle of the last century, James Clerk Maxwell showed by a brilliant piece of

Figure 1						
		Length				
Name of		Base It				
Observer	Method	Yards	Year	Vel	tioo	,
Cornu and Helmert	Wheel	26,055	1874 8	299,990	*	20
Michelson (1)	Mirror			299,810		81
Newcomb	Mirror	4,070	1882 7	299,880	#	30
Michelson (II)	Mirror			299,853		60
Perrotin	Mirror			299 601		84
Michelson (III)	Mirror	38 700	1824 6	288 802	#	30
Michelson (IV)	Mirror	38,700	1926 0	296,796	#	4

mathematical analysis that all electromagnetic waves — X rays, ultra-violet rays, infra-red rays, radio waves—would travel in a vacuum with the velocity of light, and that this velocity was equal to the ratio of an electric charge measured on the electromagnetic system of units to the value of the same charge measured on the electrostate system.

Near the beginning of the present century. Albert Einstein, in his theory of relativity, indicated that the velocity of light was the maximum possible velocity attainable in the universe, and that the velocity of light in a vacuum would be the same for all observers. This velocity was no mere ordinary physical constant, like the velocity of sound, the viscosity of water or the density of lead. It was a constant which it was imperative for science to determine with great accuracy. Römer, a Dane, had been the first to do this successfully. Previously, in the 17th Century, Galileo had tried to measure the velocity by means of distant observers who uncovered lanterns but, naturally, his method was far too crude for him to obtain any results. Romer used the diameter of the Earth's orbit round the Sun as the distance to be covered by the light, while the required signals were provided in the eclipse by the planet Jupiter of his satellites. Römer's method was only roughly accurate, and during the 19th Century Some Physicists Suspect that Changes Occur in the Velocity of Light . . . Difficult to Prove . . . On the Whole, the Ouestion Remains Wide Open

By DOUGLAS W. F. MAYER

mechanical methods were devised and scientists in all parts of the world spent years in making observations and obtaining as accurate results as possible.

Nearly all methods used were modifications of two basic methods-the Fizeau toothed wheel and the Foucault revolving mirror. In the former system, light is passed between two teeth of a rotating gear wheel and reflected back from a mirror at the distant end of the base-line. The observer adjusts the speed of the wheel so that, by the time the light has been reflected back, a tooth has moved round and cuts off the light. Knowing the length of the base-line, the speed of the wheel and the number of teeth on the circumference, the velocity of light can easily be calculated. In the second or revolving mirror method, light is reflected from a revolving mirror along the base-line to a distant reflector and back again to the revolving mirror. By the time it gets back, the mirror will have turned through a small angle. This will cause the light to be deviated. By measuring the angle of deviation with a graduated eyepiece, and knowing the speed of rotation of the mirror and the length of the base-line, the velocity of light may again be easily calculated.

DY the beginning of the present century, a large number of results of similar tests had been published, and these garte the velocity of light with varying degrees of accuracy. These results were copied from the papers originally published, but often the copying was done inaccurately, and reappeared in textbooks and scientific journals. It was again copied inaccurately for later publications. Incidentally, these usually ignored the stated degree of accuracy (exchange debody of the mittal result.

In 1927, therefore, M. E. J. Gheury, de Bray, a London scientist, undertook the praiseworthy task of looking up and summarizing all the original reports of the measurements of the velocity. He published a list of these, but pointed out how inaccurate a good many of them were, and how many of the investigators had failed to apply important corrections. A strong test of the accuracy of a

scentific experiment is for the observer to take a large number of readings, and to exceed the control of the c

After carefully studying the subject de Bray came to the conclusion that, up to 1926, only seven really accurate determinations of the value of c had been made. He tabulated these as in Figure 1, in which the second column gives the base principle of the method used, whether toothed wheel or revolving mirror, while the final column gives the determined value in kilometers per second, with the degree of accuracy.

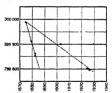


Figure 2: De Bray seeks explanation

De Bray was struck by the fact that here was a "constant" that was by no means constant, since its value seemed to vary from a maximum of 299,990 to a minimum of 299,796 kilometers per second-quite an important variation considering that c was supposed to be one of the fundamental constants of the universe. He accordingly decided to depict his results graphically, and obtained the series of dots shown in Figure 2. In this diagram the vertical scale represents the velocity of light in kilometers per second, and the horizontal scale the year in which the velocity was determined. Had the velocity of light

been constant, the dots should all have lain in a horizontal line. Actually, they appeared to lie on two oblique lines, as shown in the diagram. De Bray pointed out that the three on the left had been measured over relatively short base lines, while the three on the right had been measured over longer bases. Cornu and Helmert's reading seemed to fit in with both crows.

De Bray reluctantly came to the conclusion that those measured over short bases were probably less accurate than

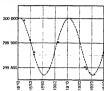


Figure 3 Edmonson's graph of 1934

those measured over long bases, and decided, for the time being, to ignore these readings. The other four readings seemed to show clearly that light was steadily slowing down at the rate of just under 4 kilometers per second per year. De Bray suggested this tentatively to the world of science, then deeded to savail further neasurements.

In 1928. Karolus and Mittelstaedt reported a determination of the velocity which gave a result of 299,778±20 kilometers per second and, in 1933. Peass and Pearson, continuing work Michelson had started at the Mt. Wilson Observatory, obtained a value of 299,774±11 kilometers per second This seemed to indicate clearly that the velocity of light was still decreasing, but the problem of the three "short-base" readings had yet to be solved.

Then, in May, 1934, Frank K. Edmondson, of Lowell Observatory, Arizona, suggested that the velocity of light may not be decreasing steadily, but might be subject to a periodic fluctuation. He suggested that a period of 40 years, with a maximum valiation of 115 kilometers per second above and below a norm of 299,485 kilometers per second, might fit the facts. Represented matter matically, this gives the formula

c = 299,885 + 115 sin 2x/40(T-1901) where c is the velocity of light and T the date of the year Represented graphically, the equation gives the simple "sine curve" shown in Figure 3. The nine dots on this diagram represent he nine accurate values then known, and the diagram shows how well they fit the suggested curve. At the suggested curve. At the sine has the superior could not be properly proved until about mill about the could not be properly proved until about

1938. If light were steaduly decreasing in velocity, the value of c, in 1938, should be about 299,760 kilometers per second, while if the velocity were fluctuating, as he suggested, in 1938 it would be about 299,835 kilometers per second.

The idea that the velocity of light might fluctuate slightly was borne out by the experiments of Pease and Pearson. In 1929, Prof. Albert A Michelson. undoubtedly the world's champion timekeeper of light, worried by the fact that tmospheric irregularities (the astronmer's "bad seeing") interfered with is measurements, using long base-lines. mbarked on the heroic task of con tructing a mile-long vacuum tube. The ead-straight, air-tight metal tube, three cet in diameter, and evacuated to a ressure of 1/250 of an atmosphere, was ud down at the Irvine Ranch, Santa un California Measurements undersken by the United States Coast and reodetic Survey revealed that the tube as 5230 76509 feet long, while by seans of murous, the light was reflected ack and forth along the tube cight times, giving a base line of about eight iniles. Three months after the tube was pnt into operation, on May 9th 1931 Professor Michelson died and the work was continued by Dr Francis G Pease, of Mt Wilson Observatory, and Fred Pearson, of Chicago University,

SERIES of 233 sets of measure-A ments was made over a period of two years, the results being tabulated in Figure 4 The final result was stated to be 299.774±11 kilometers per second At the same time, it was stated that the readings showed two periodic fluctuations in the velocity of light. One fluctuation had a period of 1434 days, the other of one year In both cases the velocity varied by about 20 kilometers per second. The shorter period fluctuation nearly vanished during December 1932 and January 1933, reappearing in February 1933. It was suggested that this fluctuation might be due to some influence of the Moon, though how such an influence might work is not at all clear. Reluctant to believe that the actual velocity of light was changing, the observers also suggested that the variation might be due to instrumental changes, such as a possible change in the length of the light path, ground disturbances, errors in the timing mechanism, or a possible effect of refractive index in the path of light. Whatever their causes, the existence of these minor fluctuations gave a certain amount of justification to Edmondson's theory of a long-period variation

De Bray pointed out that the earth's magnetic field, which is known to fluctuate, might have some effect on the velocity of light. Accordingly, experiments were made to see whether the

velocity underwent any change in a transverse magnetic field. The field used was 100,000 times more powerful than that of the carth, and the sensitive apparatus would have detected a change in velocity of one part in 20,000,000. No such change was detected. The suggestion that the refractive index of air might be changing was ruled out after referring to accurate determinations of this value made during the past 20 years

At the beginning of 1937, there came the news of another determination of c. made by Wilmer C. Anderson in the Physics Research Laboratory of Harvard University The method he used was to subject a light-beam to highfrequency modulations by passing it through a Kerr cell The light beam was then divided into two portions by means of a half-silvered murror, and the two parts were sent over different optical paths. They were recombined and focused on a photo-electric cell The difference in length of the two paths was adjusted until the photo-electric cell gave a minimum reading, indicating that the two halves of the beam were out of phase Knowing this path difference and the frequency of the modulation, the velocity of light was easily obtained

Between June 22 and December 5, 1936, 651 measurements were made, and showed no short period fluctuations which could not be attributed ducedly to physical sources. The mean result was 299,764±15 kilometers per second Later, in 1938, Dr. R. A. Houstonn of Glasgow University, Scotland, measured the velocity, using a piezo-electric crystal as an oscillator, and a base line only a few yards long. Initial tests gave a result of 299,760 kilometers per second.

These two determinations seemed to strike a death blow at Edmondson's fluctuation theory, so de Bray, deciding

			Figure	4			_
					mber		
					Obser-		
Series	Year		Dates		pation:	Velocity	
1- 64	1931	Peb	In-July	14	493	299,770 ±	12
						299,780 +	
						299,771 +	
						299,775 +	
	1030-3	-	3-4-0	•••			
1-233					2885 5	299,774 ±	11

again to neglect the early short-base readings, advanced a formula

c = 299,900 - 3 855 (T-1900) to account for the diminution of c This gives a decrease in c of 3.855 kilometers per second per year, and produces a straight line on the graph, as shown in Figure 5, which also shows the

readings now known — excluding, of course, the three short-base readings. So much for the experimental results. Meanwhile, what had the theoreticians been doing?

As was to be expected, the casting of doubt on something so fundamental as the velocity of light produced a veritable plague of theories, most of which were sooner or later proved either

to be untenable or to give a theoretical decrease in velocity of much less than 3 kilometers per second per year Most of the theories revolved around the supposed expansion of the universe. De Bray suggested that, if the universe were expanding, and if the ether were really material—a view still held by a few physicists—then the ether would gradually be decreasing in density, and the slowing down of light would follow as a matter of course. Calculations of the magnitude of such a decrease showed that it would be negligible compared with the decrease of 3.855 kilometers per second per year indicated by experiment. A similar theory was advanced by Edmondson, who suggested that doubling of the radius of the universe would cause the measured velocity to be halved. According to experimental results, however, the velocity of light should be halved in 60,000 years, whereas the universe is believed to double itself only every 1,300,000,000 years. From relativity considerations, Tokio Takéuchi, a Japanese scientist, deduced that the velocity of light will be decreasing, due to the redistribution of matter and radiation throughout the universe, but, again, the calculated decrease was far smaller than that suggested by de Bray.

OTHER scientists have been bolder. They realize that the only real evidence for an expanding universe is the shifting of lines in the spectra of distant nebulae toward the red end of the spectrum-the "red shift". Assuming that the velocity of light is constant, the red shift is explainable only by the theory that the sources of the light-the nebulaeare apparently receding from the Earth with enormous velocities. It has been

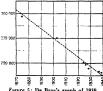


Figure 5: De Bray's graph of 1939

found that the velocity of recession is proportional to the distance away of the nebula, which gives rise to the picture of an expanding universe. The magnitude is such that nebulae at a distance of one megaparsec (3.26 million lightyears) are receding with a velocity of about 500 kilometers per second.

The bolder scientists point out that if the red shift can be accounted for by some other theory, then the nebulae need not be receding and the universe may not be expanding. Most of the theories advanced imply a change in the property of the light as it travels from the nebulae to the Earth, and several of these theories fit in with the idea of a decrease in the velocity of light.

One group of theories suggests that the energies of single packets of lightor "photons", as they are called-may gradually decrease during their journey through space, due to such causes as gravitational interaction, interaction with ionized gases which may exist in space, or simply by a gradual diminution of energy with time Such a diminution of energy would imply a diminution in frequency and, if the wavelength of the light were assumed constant, a diminution in velocity H J. Gramatzki has extended Maxwell's theory of light to allow for either a decrease of velocity with time or a change of dielectric constant with time. In both cases he showed that there would be a decrease in frcquency (that is, a red shift), and also in velocity, but again the effect would be negligible compared with that of de Bray.

Zwicky has suggested that differences might be detected between properties of terrestrial light and light from distant ncbulae. According to Pierre Salet, the velocity of light coming from stars is about 1 008 times greater than that of ordinary terrestrial light Zwicky has also suggested that the velocity of light may depend on its frequency, and that such a dependency would account for puzzling features about the spectra of certain novae Experimental tests, however, seem to refute this

In turn, de Bray himself recently came forward with a suggestion that the frequency and velocity of light may decrease with time, and claims that observed red shifts can be explained by a decrease given by the equations

case given by the equations

$$c = 299,774 - 173T$$

 $j = 762.2 - .4T$

where & is the velocity in kilometers per second, f the frequency in mega-megacycles, and T the time in millions of years. This represents a decrease in velocity of only one six-thousandth of a kilometer per second per year-which, of course, is much less than de Bray's former suggestion of 3.855 kilometers per second per year to fit the observed measurements.

Meanwhile, other scientists hold that changes in the measured velocity of light have no connection whatever with the expansion of the universe, or with alterations of certain fundamental constants. They believe that the variation is due to some undetected phenomenon which influences the apparatus in some way or another. They stress the discrepancies between observations over short bases and over long bases, and also point out that the velocity of light can be meas-

While the author of the accompanying article, a young English physicist, does not anywhere state that a varying velocity of light has been proved, and that the remaining problem is to determine its amount, it is feared that an occasional harried reader may run away with these beliefs. If questioned, many physicists might say something like this: "The chances are that there have been errors in some of the experiments, and that the velocity of light is a fixed constant. But, of course, we can't simply shut our eyes to the possibility that it is not fixed, even though this is more pleasant This article will provide background for accounts of future experiments -The Editor.

ured indirectly, with compact electrical apparatus, by finding the ratio between the electromagnetic and electrostatic system of units. This has been done with great accuracy on several occasions, and the results show no marked variation, the value of c in each case being close on 299,781 kilometers per second.

Other observers claim that, if light were slowing down or its frequency altering, such alterations could easily be detected by sensitive interferometers All such experiments to detect any alteration have given negative results.

What could possibly cause the variation in the measured velocity of light other than fundamental changes? The answer is nobody knows Apparatus more sensitive than that already used will have to be designed and constructed in order to investigate the matter De Bray has stressed the point that, in the case of the revolving mirror method. it is assumed that the laws of reflection of stationary mirrors still hold good, and that the laws of reflection of a pencil of light, from a real or virtual source which may have a transverse velocity approachmg that of light, are assumed to be the same as if the source were at rest. These assumptions, he suggests, may ultimately be shown to be inaccurate.

AT present, however, science stands at the crossroads. Experimental observations, on which the whole of science is said to rest, have presented it with a problem. Some changes have been detected in the measured velocity of light. One road leads to the type of solution involving extremely fundamental changes, the other to the theory that some new type of correction must be sought and applied. Both roads lead into unexplored territory. Which road will science follow? We can only watch and wait for the traffic lights to change.



Ships Can Carry Autogiros to Spot Submarines

MERCHANT essels need to be warmed of the proximity of submarrines if they are to elude or successfully fight them. Submarrines can be spotted most effectively from the sair, but ships cannot carry ordinary planes (plus catapults) and cannot stop, once a submarine is sighted, to host a plane shown date its water landing. Use of warships to convey liners or freighters subtracts striking power from the fleets themselves.

The autogiro, carried on individual ships and taking off from cleared present decks or built up ones, would largely solvo this problem, believe Scientific American editors. The idea, conceived in our offices over two years ago by F. D. McHugh, has been called eminently puetical by experts. Much experimentation is necessary, of rourse, but the 'giro has possibilities, as shown in our drawing. It can "jump off" 20 feet straight up and swing plant over to elear ships' super-structures. It can land with a run of about 10 feet. It can hover. It can carry machine guan to drive a submarine's gun c'ew below decks, and depth bombs to drop accurately while it hovers over the dark blob of as to drop accurately while it hovers over the dark blob of as submerged submarine. To the ship's gun crew, it can signal a sub's location and spot shell splashes by flares, Very pistol shots, or acrobatics. Finally, the autogiro can constantly patrol many miles around its mother ship.

DEEP PIERS BUILT IN STIFF TIDES



As the new bridge will look when completed. Note "lookout point"

New Suspension Bridge Near Tacoma . . . Two Deep-Water Piers . . . Enormous Tidal Current Pressure Forces Unique Anchored Caisson Construction

By CHARLES F. A. MANN

O UTSTANDING of all the large bridge projects under way as a result of the past year's Federal RFC-PWA program, is the Tacoma Narrows auspension bridge across the narrow channel lying on the westerly side of the Tacoma Peninsula, Tacoma, Washington.

Washington.

Two features of this bridge are of particular interest to engineers. One the fact that its central span of 2800 feet as the third largest such apan in the world, only those of the Gorge Washington Bridge in New York and the Golden Gate Bridge in San Francisco being longer. The other is the manner in which the engineers solved the problem of sinking two large piers to a depth of 175 and 200 feet respectively, against the enormous pressure of tidal currents double those at the Golden Gate

For more than 20 years, local people have dreamed of a huge suspension bridge across the Narrows to replace the ferries. Always two factors stymed the idea. One was the extreme depth of the

tidal current, the velocity of which, changing every six hours, reaches nearly nine knots. The second was the costliness of such a span in view of the semi-pioneer status of the section it would serve—a vast area larger than Switzerland, Holland, and Belgium combined.

A number of things brought the idea into a more favorable economic position in 1937. They were: the opening of the Olympic wonderland to tourists; the rapid growth of the pulp and paper industry; and the migration of hundreds of settlers from the midwest dustbowl to these cheap, well-watered landsall insuring greater travel. There was also the fact that the great Bremerton Navy Yard is rapidly becoming one of Uncle Sam's greatest naval bases, indicating a need for good highways and a fast Narrows crossing. Thus it was felt that a Federally supabout \$4.500,000 of its cost in 40 years. The chief task confronting the builders was that of sinking the caissons and constructing the piers. The cast spir of the Tacoma structure went down 200 feet. Tacoma structure went down 200 feet below water level and the west pier 175 feet, as contrasted to the deeper pier of the two at the Golden Gate Bridge, which went down only 100 feet. Hence it was decided to employ open-well type caissons with a wooden form built around the first part of each caisson to

perinit floating it into position and lining it up before it was lowered to the bottom. The two main caissons were 118 feet 11 inches long, and 65 feet 11 inches wide, with boat-bow points. These

ported project could easily liquidate

two una, were fabricated in Seattle and towed through the Lake Washington Ship Canal to the bridge site in Taroma

AFTER the sites for the two piers were located in the Narrows, 24 concrete anchor blocks, each weighing 600 tons, were dumped in a luge double circle around each per site These blocks were later anchored by cables to the floating seed easieson to hold them in place

against the terrific tidal strain. The

blocks were cast on huge barges and were corrugated in such a way that they

could grip the bottom mud. Having provided the anchorage, the two floating steel skeleton forms, which were covered with heavy timbering with caulked seams, were towed into place and anchored to the blocks by cable. These floating caison sections were spotted accurately by the use of shortwave radio and transits with telescopic

The caissons were partitioned into 24



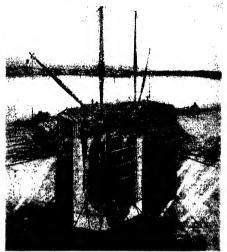
One of the monster 600-ton concrete anchors, sharply corrugated, that were cast on barges

feet 10 inches by 13 feet, all open at the bottom. Concrete was poured into the dividing walls of these sections to form a series of concrete and steel cells. As the added weight lowered the caissons a predetermined distance in the water, the anchor cables were adjusted to take up the slack, and the forms were raised so that another course of concrete might be poured. This was repeated over and over until the lower cdge of the caussons struck bottom Clam-shell buckets then excavated through these cells until the entire caussons dropped through the muck to hard gravel. Concrete plugs were then poured at both the top and the bottom, leaving the cells permanently flooded with salt water.

The Tacoma structure has a total length of 5939 feet. Towers cover an area 19 by 63 feet at the bottom and 13 by 52 feet at the top, and carry two cables 17¼ inches in diameter. Each tower weighs 1875 tons and the two cables 3817 tons. Each cable anchoring



An "anchor" makes a big splash when dumped overboard from a construction barge at a pier site

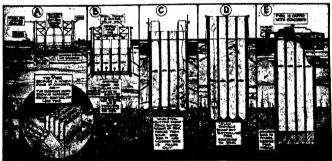


A caisson sinks lower in the water but is held rigidly by the anchors

consists of a steel and concrete mass of 25,000 cube vards weighing 52,000 tons, lodged in the hillsides above the Narrows. Each anchorage will form part of the main roadway. The bridge will have a 26-foot toadway and two five-foot sidewalks

The structure, which will be com-

pleted July 1, 1940, will reduce travel time from mainland to pennisula from 40 minutes to 10 and will be the best lighted structure of its kind. Towers and cables will be outlined in lights and the roadway equipped with sodiumvapor fog lights. Airplane beacons will be mounted atop the towers.



Step by step, a pier is constructed. Slack in anchor cables is taken up as caiseon sinks lower

Answer, Echo, Answer

E CHO, according to the Greek mythom was a mymph who pined away for love till only her voice remained. This charming legend makes pleasant folklore, but the science of sonics has given the echo a much firmer basis Although echoes still possess as poetic, eerie quality, we can now explain how they magnify sound, return some voices and ignore others, convert discords into music, carry whispers over long distances, and perform other weird feats which challenge the imagination.

Echoes are sometimes the radio stations of nature; without wires or sending-apparatus, they "step up" sound vibrations and hurl them enormous distances. Some years ago, 28 tons of dyna-

mate exploded in an Alpine railroad tunnol. The terrife blast was heard by Swiss peasants 20 miles away, the apparent him of the sound. Villages some 25 or 30 miles fartlier off heard nothing. Then, extraordinary news popped up 100 miles to the north, across the border in Germany, the noise of the explosion had been distinctly audible Had the sound of the blast "jumped" over a region 80 miles wide?

"Yes," said the Swiss Meteorological Institute. What had been heard in Germany was not the direct noise of the explosion, but an echo of it Every echo is,

you know. "mirrored" or reflected sound in this case sound waves, concentrated by the tunnel in which the explosion took place, had traveled upward, reached a heavy cloud fornation perhaps 50 miles to the north, which amplified and then reflected the waves to points more than 100 miles from their original source.

Everyone knows that curved or angled mirrors can play curious tricks with an image Sound-mirrors (another name for echoes) act similarly they "bounce" sound waves from surface to surface, often altering their volume, pitch, and number of repetitions. Probably no echo has ever achieved the record described by Mark Twain- "you could ntter a word and it would talk back at you for 15 minutes" But there is an echo in Oxfordshire, England, which repeats a pistol shot across a valley as many as 20 times the sound shuttling back and forth between two hills. Like some actors, this echo gives its best performance at night. There are Echoes that Magnify Sound and Others that Change Harsh Discords to Harmony . . . Echoes that Analyze Sound . . . Whispering Galleries

By ALBERT CARR

It has never been heard to score more than 17 repetitions by day, the differ ence is believed to be due to the more uniform temperature of the air at night A unique multiple echo exists at the Menni suggestion by Meles.

Menai suspension bridge, in Wales There, a hammer blow on the main pier is returned in a series of staccato reports from each of the clossbeams, all the way

POURCE SQUIND LETTENSE SQUIND SQUIND SQUIND OR ECHO

Reflected sound that is clear and definite is an echo

across the river—576 feet. To get an equivalent result with light, you would have to get up a long row of mirrors, equally spaced, and place an object in front of the row, at a wide angle Then, by standing in the right position, you could see an image of the object in each mirror all the way down the line.

miffor all the way down the line. Some echoes dusdam mere numerical glory and strive for a single brilliant performance. If, near a certain tomb on the Roman Campagna, you speak an entire hexaneter verse, the echo will construct the stripe of the stripe of the control of the stripe of the stripe of the stripe of the control of the stripe of the stripe of the control of the stripe of the stripe of control of the stripe of the stripe of the deserted city of Mandu, in Central India, there is a spot where you can utter a long, solid sentence, and have it voyage back presently to your ears, unbroken.

To produce one of these marathon echoes, the sound reflector must be so far away that you have time to speak for several seconds before the waves can make the journey to the reflecting surface and back again. Sound travels a mile in about five seconds; an echo which will repeat a five-second sentence therefore indicates a reflector half a mile away. Only extraordinarily clear acoustic conditions will permit the voice to carry so

far; hence the rarity of this type of echo.

As some curved mirrors magnify your image, some echoes magnify your voice.

Usually such "megaphone" echoes are heard in caves. At the famous quarried grotto known as the Ear of Dionysius, in Sicily, the crumpling of a piece of Cellophane will make you think a machine gun 14 at work. Why? Well, when echoes are thrown back simultaneously from many surfaces, their combined volume is louder than that of the original sound heard from a single direction. This phenomenon was once utilized by a troop of Mexican bandits when tranned by a superior force in a mountain pass Discovering that the crags around them multi-

plied both the volume and number of their voices, the bandits tried desperate expedient. Yelling and shooting, they dashed for freedom. The echoes, resounding from all sides, made the enemy believe that a regiment was charging down on them; they field and the little band escaped. This story, long current south of the Rio Grande, has furnished at least one movie episode for Hollywood.

Mark Twain, veteran echo-fancier, claimed he knew an echo which would speak only German. We may smile at the notion; but there are some echoes which are highly particular about the sounds they will do business with. One English echo has been called "The Suffragette," for, while it will respond to a woman's soprano voice, it pays no attention to a man's.

tion to a man's.

This sex-conscious echo does to sound what a colored mirror does to light. In a polished red vase, for example, you will notice that the reflection of blue objects



Direct sound of a dynamite explosion in the Alps, as the author describes, was heard in the area up to point A, but not in the zone of silence from A to B. The echo from heavy clouds, however, was heard in the distant area from B to C

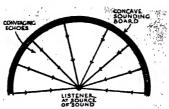
in it lose their color. The red light-rays of low frequency are reflected, while the high frequency blue rays are largely absorbed. The "selective" echo acts in the same way, throwing back some sound-waves in greater proportions than others

The chief factors in this phenomenon according to authorities on somes, are the size of the sound reflector, and the variation in the wavelengths which compose a complex sound like that of the human wors. Lord Rayleigh, the famed English physicist, showed that the intensity of sound scattered or reflected by an obstacte is

directly proportional to the size of the obstacle, and inversely proportional to the fourth power of the wavelength. (The same law, medentally, applies to the scattering of light, and is used to explain the blueness of the sky)

When, according to this law, sound waves of various lengths traveling the same plane encounter a small obstacle, the longer waves tend to continue beyond it, much as large water waves pass around a rock and close in again on the other side, without substantial interruption The shorter sound waves, on the other hand, are scattered, somewhat like small water waves encountering the same rock. Consequently, when the sound reflector is small, the chances of the scattering and reflection of short sound waves are much better than those of long sound waves. Since the shorter waves represent the higher tones of sound, it is these tones which we hear most loudly when a small, distant reflector happens to produce an echo.

Certain selective or "harmonic" echoes have the curious trick of raising the pitch of sounds. At the Gap of Dunloe, in the lakes of Killarney, it is said that



How echoes are magnified The sound waves, having traveled out from the source in all directions, smultaneously converge back on the shouter from all directions, causing more intense vibration of the eardrum than was made by the original sound. He virtually shouts mouth squants ear

the glass, of a long dead musician will accompany whover plays a high there. It is perfectly true that the echo of each note comes back an octave higher, and that it provides a harmonium accompaniment for a simple bugle call. The principle is that of the selective echo, a small obstacle, such as a clump of trees, will return the first harmonic wavelengths, or octave, of a fundamental tone more efficiently than the tone useff.

Everyone has observed how a prism or spectroscope grating breaks up sunlight into its component colors. Here and there an cho will do the same thing to sound, producing a "sound spectrum." At Bighorn Canyon, in southern Montana, the rushing roar of the river is sometimes echoed from a certain section of the cliffs in a howl like that of a police-car siren, beginning on a high note and sweeping down into the bass clef. Years ago Indians in the neighborhood used to shun the spot for fear of "evil spirits" Today we know that the various wavelengths in the sound of the river are reflected by different parts of the jagged cliff, reaching the ear separately, instead of all at once If the observer takes an

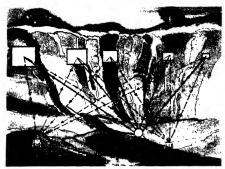
other position, he can cause the order of the sounds to be reversed, so that the echo begins with the deep tones, and rises to the treble Physicists say of echoes of this type that they "analyze" sound

I remember standing nearbagle Harlor, on the wooded shore of Lake Superior, and hearing what sounded like a celestial hymn, played in alow time by some mysterious organist For a while I thought I had suffered a halliemiation. But similar experiences of others in that region show that what I heard was the roise of the waves of the lake on a pebanalyzed and echoed har-

bly beach, analyzed and echoed harmonically by the forest behind

The musical or ho is certainly the most charming of all the numerous excho family. Its principle weems to be to repay wil with good On Saddleback Momnatan in Maine, the most hideous discords—such as an Indian war-whop—are returned as a delightful, soft, musical note Scale reloses are generally found only where there are symmetrical rows of trees which "cut out" or abort certain sound frequencies, and reflect the others in a harmone relationship.

Perhaps the most dramatic of all echoes are those in which the sound is reflected from deeply curved surfaces. The whispering galleries of the world are all of this type One of the best known is under the great dome of St. Paul's Cathedral in Loudon. There a whisper will creep across from one side of the dome to the other, to be picked up with astonishing distinctness on the opposite side, 102 feet away. The Ear of Dionysius, already mentioned, is one of the finest of all whispering galleries. At its top is a small passageway where the visitor can distinctly hear the breathing



An abstract diagram of the action of an "analyzing" echo. Large reflecting areas throw back more of the deeper sounds; small ones more of higher sounds. Owing to differing total path lengths these "analyzed" echoes arrive in succeesion, but from high to low for one listener, low to high for the other

of a man on the floor, 120 feet below. The tyrant, Dianysius of Syracuse, conceved the notion of imprisoning political enemies in the Ear, and by listening at the top, was able to overhear their whispered plots and secrets.

How is it that a whisper which cannot be heard for 20 feet under normal conditions will carry 10 times as far in a whispering gallery? The explanation hes in the fact that the sound is "slanted" off the smooth inner surface of the round done again and again, traveling in a series of arcs. A helpful analogy is to magine a billiard ball with "forward spul" as it strikes a cushion at an acute angle. Under the right conditions the ball instead of heing slowed down, 'picks up.' Similarly, the volume of sound "picks up.' Similarly, the volume of sound "picks up.' in whispering galleries as it travels over the curved reflector.

E CHOES have been used as a method of torture. In the Cave of the Snake. in the wrinkled and lonely hills of the Kamun Range of India, the least sound is repeated in a low rushing murmur that seems to pervade the doomed chamber A torture-loving Raigh once conceived the notion of putting his victims. one at a time, in the pitch blackness of the cave with no company but that of a deadly black cobra. There was no way of telling how soon the cobra would encounter its destined victim, and strike But every time it moved or lussed the slithering sound would seem to come from all directions. Under the unbearable suspense the prisoner would die a thousand deaths before the fatal moment came

However, the Rajah felt that in not overhearing the sufferer's torture he was

missing the best part of the fun. So he had a small opening made in the sealed entrance. And—as was to be hoped while he sat with his ear to this opening, the snake erawled up and bit him.

The best known of America's whispering galleries is in the Capitol at Washington, in Statuary Hall, where if you stand in the proper spot you can communicate by whispers with a friend 50 feet away.

Most land echoes seem to have no other purpose than to entertain the currous. But at sea, echoes work for their living, measuring ocean-depths for navgators. The echo depth-finder used by the United States Coast and Geodetic Survey in charing the bottom of the ocean, and earned by particelly all important vessels, enables a shy running at full speed to obtain four soundings a second in depths of 600 feet. 'Sound, be it noted, travels approximately five times as fast in water as in air.

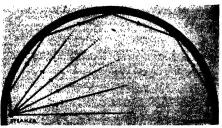
The principle of the instrument is simple enough. Sound waves, produced under water, speed to the ocean bottom, and are reflected upward. An electrical device measures the elapsed sound and the return of the echo, and this time interval is recorded in terms of depth. In war time these depthinders have helped ships to detect the presence of submarines by recording the sound whost the results.

The story goes that many years ago, in the cathedral at Grigenti in Sielly, a gentleman was kneeling alone near the high altar, when he suddenly heard a distinct whisper have sinued. "Bless me, father, I have sinued."

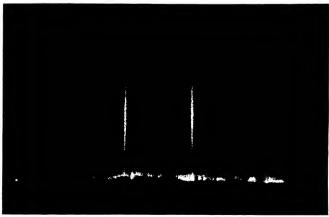
Startled, he looked around. There was no one near him. The whispered confession continued. Amazed, he concluded that it could only come from a confessional booth over 100 feet away. He approached the hooth, but at one the whisper ceased. Returning to the original spot, however, the heard the words as clearly as if they were being muimured into his ear.

Unfortunately, he was not content with the discovery of an acoustic plic nomenon. Delighted at the prospect of rare entertainment, he invited some of his friends to join him nearwidropping on the confessions of their neighbors. But, appropriately enough, in the very first confession, he heard the sound of his own wife's voice admitting sins no husband cares in have on his wife's conscience.

A MONG rchoes as among people, there is infinite diversity. One finds on only easygoing, good-natured schoes, but grumblers, loud-mouthed bores, wiserackers, show-offs, temperamental artists, and a few hard workers. But Little Sir Echo always has one advantage over merely human sound-makers. No one expects him to be original



Sound creeps around the concave wall but soon becomes attenuated elsewhere



Spectacular pillar halos at Wilbur, Washington, photographed at 12:15 A. M. by S. B. Breed. Five-minute exposure at //3.5

PILLAR HALOS

XCITEMENT Caused by Freakish Lights" was a headline in the Wilbur (Washington) Register. "Last Thursday night," the news item beneath it stated, "those of our citizens who were awake witnessed a display of freakish lighting effects that is seldom equalled for beauty. From every outdoor light-street lights, electric signs, and automobile headlights-there arose perpendicularly a shaft of light high into the air. Within these ghost-like beams there flickered and danced millions of particles of frost." On this occasion one Scientific American reader. S. B. Breed, of Wilbur, thought to photograph the odd phenomenon and sent this magazine the illustration shown above, with a request for a scientific explanation.

When readers send this magazine decriptions of odd meteorological or atmospheric phonomena for explanation, the editors turn to W. J Humphreys' "Physics of the Air," a standard advanced reference work about this particular corner of science; often also, as in this case, to the author himself, Dr. Humphreys, because his lifetime work as Professor of Meteorological Physics at the United States Weather Bureau in Washington, has brought to his attention myriads of meteorological oddities. "The photograph," he replied, "is of pillar halos and is the best I have seen of that phenomenon Pillar halos," he continued, "are produced by reflection from the upper and under ades of tabuses "in extension of his comments wise." In extension of his comments wise." In extension of his comments the Monthly Weather Review of the United States Weather Bureau, by B. W. Currie, Professor of Physics at the United States whether Bureau, by B. W. Currie, Professor of Physics at the United States whether Bureau, by B. W. Currie, Professor of Physics at the United States whether Bureau, by B. W. Currie, Professor of Physics at the United States whether Bureau, by B. W. Currie, Professor of Physics at the United States of the United States and the United States of
"The color of the light from the pillars, and its state of pulsarization, show that they are caused by reflection. The color of each pillar is exactly the same as that of the light below it, the red pillars from neon electric aigns are particularly noticeable. The apparent height of a pillar increases with the intensity of the light source. Calculations based on known distances to light sources and the measured sizes of the corresponding pillars on photographs often give heights in excess of 1100 feet.

"Two kinds of crystals—thin hexagonal plates and thin broken fragments of snowfikkes—cause the pillars. Only the first kind is found on calm nights when the most brilliant displays occur. Both kinds of crystals may be found when the pillars are seen on windy nights.

"Wand velocities less than eight miles per hour seen seentual to the formation of bright pillars. If wow is falling, the pillars can be seen only if the wind is strong enough to break the snowflakes Temperature conditions show no untormity, partly because the cryatis are formed at higher levels and then fall to the surface."

Sometimes pillar halos are similarly seen above the sun or, if the sun is high, below it as well.

Related directly to pillar halos are several phenomena which do not at all resemble them in shape: certain arcs and circles, seen surrounding the sun. often in elaborate complexes like schoolroom exercises in geometry. All have scientific names such as perhelic arcs and circles, anthelic arcs and heliac arcs. But the plot rapidly thickens, for a part of these are caused by reflection, and, to complicate the complexity, there is a third class of ring phenomena due to diffraction: coronas, solar or lunar. Halos are red inside, blue outside, coronas the reverse. Writers often confuse the three classes and who can blame them? Short of close study and perfect memory it is safest not to leave the vicinity of a textbook.



MONTHLY DIGEST

BIKE TIRES TESTED

TIKE its big brother, the automobile tire, the bicycle tire now undergoes actual road tests in addition to laboratory check-

ups to insure serviceability. On a unique machine invented by engineers of the Fisk Tire Company, four bike tires can be tested at one time by means of a trailer arrangement hooked to the rear of an automobile.

The four tires run simultaneously, each under an individual load of 125 pounds. The



Heavily loaded tires under test

automobile pulls them at 25 miles per hour, rain or shine, to simulate actual service conditions

According to A E Benson, Fisk product development manager, the tests provide the following information Behavior of tire on different types of rims, resistance of carcass to fatigue at different inflation pressures. stability of beads in maintaining a true running tire, resistance of tire to rim cutting, quality of rim strip in resisting indentation of spoke heads; quality of tube in maintenance of air pressure and freedom from excessive growth, and quality of tread stock resistance to wear

Indoor tests on another machine provide a double check on the same conditions

PERFECTED "RUBBER Lung"

SHORT time ago newspapers carried A SHORT time ago newspapers carried the story of the first use of an artificial lung on a mother during childbirth. The mother was afflicted with paralysis a short time before the child was to be born and had been kept in an iron lung. Delivery was, of course, impossible while she re-mained in this machine, so a smaller, newly Conducted by F. D. McHUGH

Contributing Editor

ALEXANDER KLEMIN In charge, Daniel Guggenheim School of Aeronautics, New York University

developed lung was borrowed from the family of a paralysis patient, Fred Snite The delivery was successful

The small lung which served in this case was one which was discussed in Scientific American about two years ago, and was de veloped in part by the General Tire and Rubber Company In an accompanying illustration will be seen the latest perfected model of this lung, which not only provides the patient with a regular rhythmical supply of air but leaves the limbs free for any neces sary manipulation or massaging by nurses It will be noted that an additional feature of this is the transparent plastic cover through which the patient's chest action may be observed. This device, when strapped over the chest, is sealed around the edges by sponge

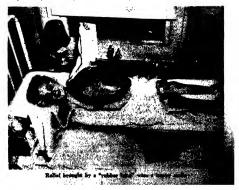
rubber. This emergency lung, which is called the "General-Collins," is easily transportable,

by a hand pump if electricity is not available, and is so mexpensive that it might be carried as regular equipment in even the smallest hospitals, in police emergency squad cars, fire-fighting units, and by first-aid organizations of all kinds. It has been designed in four sizes to care for patients from infants to large adults

BACTERIA CAUSE KEROSENE EXPLOSION

BRITISH authorities have for months been puzzled by mysterious explosions in gasoline storage tanks holding their war time fuel Sabotage was suspected but un proved, for the terrific explosions brought complete catastrophe. Finally a kerosene tank blew up and, after the explosion, bubbles of gas were noticed rising from the layer of water at the tank's bottom on which the kerosene had been floating

The government's expert on the generation of gases by bacteria, Dr A. C. Thaysen, examined some of the water and sediment It was found that they contained a new kind of bacteria which can live in kerosene and fernient it into 10 percent ethane and 90 percent methane It was undoubtedly



these explosive gases, generated by the bacteria, which caused the explosion. While Dr. Thaysen has not solved the puzzle of the gasoline explosions, he is virtually cer tain that a similar action was responsible Science Service.

BLOOD

THE Japanese are said to have added to the soldier's name on his identification tag, which he wears around his neck, one of the letters: O, A, B, or AB. Precious time is thus saved if the soldier is wounded and needs a blood transfusion, for the letters indicate his blood type, previously determined

DE-ENAMELING LIGHT SHEETS

TO its line of sand-blast guns, Michiana Products Corporation has added a new model which is now being used by makers of vitreous enamel products, such as stoves, refrigerators, cabinets, and sinks, for deenameling defective sheets or parts which are ordinarily a total loss. This new gun has five outlet nozzles or orifices through which the sand is discharged with a brush like action, cleaning without peening or distorting sheets 19-gage and lighter. Be-



Sand hlasting for reclamation

aides de-enameling, the makers recommend this type gun for cleaning wood, stone, and other materials, the surfaces of which might be damaged by a harsher, single nozzle

GAS-COOLED COMPRESSOR

'HE world's most powerful air-conditionng compressor unit, with a cooling ty equal to the melting of 100 tons in 24 hours, has just h ust been announced de & Manufacturing



For defense against low-flying aircraft

all air-cooled and required much more space This new equipment, therefore, has 12 percent more efficiency and its space requirements have been reduced by two thirds of importance to theaters, restau-

100-MILE-AN-HOUR

ANTI-AIRCBAFT COMBAT CAR

E QUIPPED with three machine guns and a cannon, capable of traveling more

than 100 miles per hour, built of .50-caliber bullet-proof armor plate and glass, mounted on bullet proof tires, able to climb grades of 50 percent inclination and travel through mud, sand, and broken ground, having a cruising range of 225 miles at 70 miles per hour, as easy to drive as a motor car -- that, in substance, is the newest type of anti-aircraft combat car.

This new mobile unit is a powerful arm of defense against lowflying aircraft on ground strafing missions. Its armament, speed, maneuverability, and bullet-proof construction make it always ready for in-

stant use Designed by Preston Tucker of Tucker Manufacturing Company, this "tank" was made possible by use of the most modern steel construction process—are welding Arcwelded construction actually makes the ma-chine hullet-proof. Welding does away with bolts and rivets which hecome worse than projectiles when driven into the tank by heavy gun fire. While eliminating this hazard, the arc welds are themselves bullet-Welding on the Tucker Tank was done with electrodes and arc welders manufactured by The Lincoln Electric Company.

This tank is equipped with one 37mm full-automatic cannon firing at a rate of 120 shots per minute, and three .30-caliber mashots per minute, and three 30-caliber ma-chine guns. The turret rotates freely, giving complete firing range, and all glass is 2½ inches thick and so placed as to give full

stability.
A most of TIA miles an hour is possible
that the appropriate motor belong a seron-

speed transmission. In addition, the unit has a 108-inch wheel base and a standard racing-car arrangement in springs and chassis. Tires are apparently sponge rubber 'airless" type.

Radio equipment and compass are con tained in the interior which is air conditioned for comfort

TREES

MORE than 6 mill on trees were planted in windbreaks and shelterbelts last year in a total of 30 states.

ERSATZ RUBBER

WITH synthetic materials in many instances replacing more expensive and less satisfactory natural products, the question is often raised as to why substi

tute rubber remains so high in price
Using the production of Buna, Gernany's substitute rubber, as an example. Plastics (London) points out that the process is so complicated that certain basic costs cannot be decreased The works plant is costly, maintenance is much higher than in ordinary plants, the highly inflammable materials need special precautions, continu ous testing and research are expensive, but necessary, adminels. But the mein reason for ligh cost is the fact that there are so many intermediate processes The first step is the manufacture of car

bide from lime and coke in an electric furnace using 10,000 volts. This needs a sizable power station to produce the necessary 100 to 200 tons of carbide a day. The carbide is then treated with water to produce acetylene The acetylene is trans formed by catalysis and hydrogenation into the chemical butylene glycol. The yield of these two processes is only 35 percent The yield of the theoretical. Two more steps, another transformation, and a polymerization, yield the rubber substitute. The polymerizing agent is metallic sodium, difficult to handle.

To make one ton of rubber, four tons

of acetylene are required. And to make this quantity of acetylene, at least ten tons of carbide are needed.

It is interesting to note that, should the cult of self-audicioncy die out, the production would decrease and the price would increase. And, as in the United States, the use of the synthetic material would be restricted to its proper and special uses hased on its inherent advantages over the natural material.

AERO-BIOLOGY

HAY fever victims will find aviation an aid in their woes if the researches "aero-biologist" C. C. Durham, of the Abbott Laboratories, are successful. Dr. Durham is a botanist who investigates the distribution of pollen with the aid of a microscope and a kit of Vaseline-covered slides The slides are fitted into a "skyhook," and flight investigations of the upper atmosphere have been made with the aid of United Air Lines, Pan-American Airways, and Pennsylvania Central Airlines. Above 6000 feet there is little ragweed or other irritating pollen to be found. Even at ground levels in the Pacific Northwest the air is virtually free of any hay-fever-causing pollens. Flying in the Yankee Clipper, Dr. Durham's slides show no spores farther from land than 275 miles Sufferers from hav fever had better spend their lives flying. particularly flying over the Atlantic ! -- A.K.

THE ASBOTH HELICOPTER

W/E have described at some length in these columns the remarkable characteristics of the Focke helicopter, which is of the type where airscrews, turning in contrary directions, are mounted on each side of the fuselage Now, thanks to the Aeroplane, (London) we are able to give a description of the latest Asboth design. which is apparently to be built in England. The Asboth machine, illustrated in the drawings, is known as the A H. X With a Cipsy engine of 200 horsepower, a gross weight of 2148 pounds, and a disposable load of 385 pounds, the A. H. X. is estimated as having the following performance Maximum horizontal speed, 107 miles per hour, ceiling, 11,500 feet; initial rate of climb, 1760 feet per minute, lift, 3260 pounds, giving an excess of lift over weight of 1100 pounds Speed of vertical descent



End view drawing of the Asboth helicopter. Wheels retract into wing

with the blades auto-rotating is somewhat high, in the neighborhood of 40 feet a second, although the vertical descent speed can be reduced to 16 feet a second by gliding the machine down like an airplane or an auto-

The drawings give only a hint of actual construction Incidence of the blades is varied from hub to tip. If the engine fails, the incidence is automatically changed, so that auto-rotation follows. Without automatic auto-rotation, a helicopter would be a dangerous vehicle when the engine quits.

The blades are set rigidly on the hinge and do not flap. There is a "four function" hub. The hub ellows the six-recws to be tilted forward to give forward thrust, and permits auto-rotation as previously stated. Control surfaces are carried in the faired heam, which is really a small wing The landing gear retracts into the wing, and



the now commonly accepted tricycle landing gear is embodied in the design. We admit that this is a sketchy description and hope that more details will shortly be forthcoming. In the present state of the art it is highly desirable that both the superimposed aurscrew type of helicopter and the outboard airscrew type should be developed in competition with one another—4. K.

THE FUTURE OF

DR 11 E WIMPERIS, former Director of Research of the British Air Min istry, is a man of vast experience in aeronautical matters. His recent address before the British Association for the Advancement of Science, on the future of flying, may therefore be regarded as an authoritative view of thinas to come

Speaking of materials, Dr Wimperspoints out the virtue of the high-strength aluminum alloys so generally employed to day in the building of aircraft. But aluminum alloy means hundreds of thousands of rivets in a large airplane. Therefore, plastic materials, while no better from a strength point of view, may mean real improvement in production methods.

What is the position regarding speed? Physiologically there is no limit to speed, provided only that high speed is not associated with rapid maneuer Does not the carth sipn around at vast speed without incommoding us in the least? But there are two probable limits to sirplane speed For commercial aircraft this should be around 250 miles per hour, simply because the forecommercial aircraft this should be revoluted to the between 500 and 600 miles an hour, because of the "compressibility burble" which occurs near the speed of sound, and which even the best arfolia cannot postpone indefinitely. With compressibility burble, the drag or air resistance increases enor-

What of the engine? Three thousand horsepower in a single unit is n sight. One great improvement which has entered British but not American practice is the sleere-valve to replace the conventional oppoper valve. The alever-valve is no novelty (if has been used in the automobile) and it has only half the component parts of the ordinary popper valve, permits inlet and configuration of the product of the configuration of the con

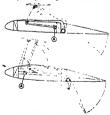
the cooling air to produce thrust. In such a case, instead of drag, the cooling system may actually produce forward thrust!

may actually produce to twater threat:
Special wings may be developed which
will keep the flow over the surface of the
mittel laminar instead of tradeless. With
mittel laminar instead of the mittel with
mittel laminar instead of the mittel with
mittel laminar instead of the mittel with
then the position of the propeller must be
changed. It is not the slightest use to
design "laminar flow" wings if the slipstream of the propeller placed at the leading
edge of the wing upsets the air flow. Dr.
Wimperis therefore argues in favor of the
pusher propeller introduces
problems of its own, such as moving back
of the engine and change in tirm or balance
of the aircraft; the ner easty of a long shaft
drive from the engine, with attendant wibration troubles; and proximity of the propeller
laspitation to the tail surfaces. Nevertheless, the combination of "laminar flow"
wings with pusher propellers offers an

The higher the wing loading, the greater the speed and carrying capacity. The Wright brothers carried a loading of 1½ pounds per square foot of wing area. Dr Wimperia speaks of a stall append of 100 miles per hour, and wing loadings of 40 pounds per square foot Particularly in transallantic Rying we may expect tre mendous wing loadings to permit non-stop mendous wing loadings to permit non-stop hours are the properties of
These semi-popular, semi-technical views of a well-informed man are helpful to both layman and technician —A K

PUSHING THE FLAP

THE flap has proved itself highly useful In airplane design, but aeronautical engineers are never satisfied. Therefore, double-flaps, designed by H B. Irving, are being tested in England. Our own N.A.C.A. is experimenting with a Venetian-blind type of flap with promising aerodynamic results



Two types of the Pidcock combination "slat" and flap for planes

to compensate for mechanical complexity. The Aeroplane (London) describes briefly the Pidocok combination of forward "dair" and flap illustrated in two of our drawings. In the Pidocok combination, the effect of the flap in increasing the lift capacity is combined with the lift increase effect of the slat which emerges from the surface of the

wing, and gives a biplane effect. The inclination of the forward slat can be adjusted by the eccentric at the points A on the drawings. There is another reason why the combination of slat and flap is worth considering: The depression of the flap tends to nose the sirplane down; such a tendency would be counteracted by the lift force forward of the slatt—4 K.

CONTRAST IN TRAINING

PLANES

TWO of our photographs show a definite contrast in modern training planes. The Stearman PT-13A Army primary transing plane is a biplane, powered with an engine of more than 200 horsepower, with a top speed of around 150 miles per hour. The Stearman is a rugged biplane, of short here is a regardeness available for the most violent stutting. The cockpits are open so to give the "freed of the ari" to the pilot on the pilot of the most violent stutting.

The Porterfield Model 50 is a decided contast it carrier only a 50-horspower Contamental engine, of the four cylinder opposed type, and the open cockput can be converted into a confortable cabin with plenty of vision. The Porterfield Trainer has been apecually designed for the thousands of students who will undertake C. A A flight training all over the country the small shape now being used for such training—the Porterfield, Aeronca, and so on—are remarkably economical, easily

ers across the North Atlantic straight from factories in Ganada is much more practical. In fact, the Albes may expect a great deal of help in serial warfare from Ganada. The Society of British Atroraft Constructors tells us in a new letter that II major Canadian engeneering firms are handling aircraft production work, and that the pulse of production us quickening every week. The network of factories is spread throughout the Dominion, with torpedo planes being built as far west as Vancouver. Our northern neighbor has a great opportunity in military avanton—JK avanto

IS THE WESTWALL. INVINCIBLE?

IF Germany's bristling Westwall proves invincible to attack in the present war, it will be the first great wall in history that has ever completely justified the trust put in it, says Science Senice

China's Great Wall, a berrier 1500 milelong, 15 to 30 feet high and reinforced by thousands of towers, was built to shut out barbarrans who kept swooping down from the north Costing thousands of Chineslives in the construction, one flippant crack later summed up its worth. "The Chinese nevey got over it but the Tartars did"

Two modern training planes with desirable characteristics. Below The Porterfield Trainer, and, right, a Steaman primary trainer



Minich began working with this product

and developed a machine with which he

does things to it. From Pliofilm, treated

and turned into Tensolite, is made a dental

floss, bristles of many kinds, tape in numerous colors, and, even a fiber as fine as

cocoon silk. One of the bristles has an

abrasive core, so that when made into

brushes it will abrade a surface at the same

time that it polishes. Sheets have been

made that are, in the commercial grade,

.0002 of an inch thick, but experimentally

they have been made to a thickness of 00008

of an inch. This last sheet puts the word

ın sır.

gossamer" to shame, for it actually floats

Tensolite laminations in different colors

are made into attractive striped tapes End-

less belts may be made from it; or colorful

sheets for such things as raincoats, each side

of a different color. Air-like filaments have

made very satisfactory fishing lines and lead-

ers, badminton and tennis racket strings, yarns and threads and tapes have been woven into cloth, belts, trimmings, and baskets

All Tensolite products are proof against water, oil, grasse, acid, alkah, perspiration, mold, and vermin. They stand all normal temperatures, are non-explosive, and can be printed They have long shelf life and may be cleaned with soap and water or may he dry cleaned. They must not be rorned, but can be pressed readily with weights. While the original Plotfin supports slow combustion, Tensolite contracts so rapidly in the presence of fiame that it actually runs away from the flame statully runs away from the flame.



handled, of slow landing speed due to their low wing loading (6.5 pounds per quare foot on the Porterfield), and safe in students' hands.

Neither the operators who give the in struction nor the students who undertake it have any reason to complain of the equiment at their diposal. Main data on the Porterfield Transer are: High speed with open cockpil, 95 miles per hou; gross weight 1100 pounds; useful load 455 pounds; length 22 feet of inches; wing span, 34 feet 9 inches; wing area 168.8 square feet. The students for whom Uncle Sam is providing flying training are to be envised—4. K.

CANADA TO THE RESCUE

THERE was a beautiful ides propounded in the press that British and French warplanes could fly to Poland's aid and shuttle back and forth, dropping deadly bombs on the German forces. The great distances involved and the destruction of the Polish aerodromes rendered the plan unfeasible. But the scheme of flying bomb-

Iladrian's Wall, which crossed Britain from coast to coast, fortified Roman Britain against invasion from tribes of the north Although the last word in 2nd Century A.D. multary construction, the strongly fortified barrier was atormed and broken during more than one conflict.

In Germany itself, Rome's old Limes Line that marked the limit of conquest was not particularly heavy, but the Romans thought it adequate when they had backed it by block-houses and manned it for defense. When internal troubles weakened the empire, however, Franks and other tribes ran over this great wall and swept on in triumph into Gaul

TRULY VERSATILE

A NUMBER of amazing products of Tensolite, were shown us recently by Henry D. Minich. Rubber hydrochloride has been known or a number of years and was introduced in a stabilized form by the Goodyear Tirq and Rubber Company in 1934 under the now well-known name Pliofilm. Mr

TAR

THE average smoker lines his lungs with 8 quarts of tobacco tar in a period of ten years, according to the estimate of Dr. Angel H. Roffo. of Buenos Aires. Argentins.

SULFAMIC ACID

RECENT development of a practical process for commercial-scale manufacture of sulfame axid (HSO,NHs) has stimulated a wide interest in this new mudustrial chemical. According to Industrial and Engineering Chemistry, a number of industrial uses based on the unique chemical and physical properties of the



With simple equipment amateurs can make sound-on-disk talkies

acid have already been developed. One such use is based on the rapid reaction of sulfame acid with mirities to yield nitrogen and sulfure acid.

A novel industrial application of this reaction is its use for the necessary removal of excess nitrite following one of the steparce which is command used for such pure. Sulfamis acid is two to six times more effective than area which is commonly used for such purposes. Higher concentrations of intite may be in most cases may be shortened from a period of hours to a period of a few minutes Cleaner shades of color and greater uniformity are thus made possible.

FLUORINE FILTERS

In some sections of the country, mottled teeth have become a serious problem because of the fluorine in drinking water. This cause of insightly teeth, discovered only a few year, ago, has set many research scientists working on ways to chimiate it Dr. H. V. Smith of the University of Arizona. College of Agriculture, reports some success in this direction.

Or Smith has invented a small filter cartridge, adaptable to drinking fountains, and made of home. Another type is larger and suitable for treating the water supply of schools or homes. An electric alarm is set off when the filter in the latter type has absorbed all the fluorine it can and hence needs replacement

The bone filter is made by treating animal bone with caustic soda, then washing it with water and finally neutralizing it with a dilute acid

ARC-WELDED STEEL RIVER TUNNEL

CHICAGO'S new river tunnel, a double tube of steel, 200 feet long, 40 feet wide, and 25 feet high, which is to carry State Street subway cars under the Chicago River, is the most intricate job in Chicago's new subway system. The guant tube will rest in a trench dredged to a 30-foot depth below the river bottom and will be sealed at both.

ends, towed 15 miles to its site and sunk by pouring concrete on its top

Different from ordinary procedure in tun nel work, (which involves boring beneath the river bottom), anking the section as unit minimizes the depth of earth covering over it—five feet as against 15 with conventional practice. The shallower depth has the added advantage of providing a slighter grade in and out of the tube than would be the case otherwise

How Effective Is Aluminum Foil. Insulation?

R ECENT investigation of heat transfer sheet of alumnium foil placed midway in a horizontal air space with the heat flowing downward is equivalent to approximately three inches of corkboard in insulating value. With three layers of foil in the same space, the heat transmission is reduced to

almost half that obtained with one layer.

The investigation also showed that the eye, while a good judge of reflectivity, cannot evaluate aluminum as an insulator. Surface films formed by exposure to laboratory tumes and dust, salt spray, and by normal use as a house insulator are readily visible to the eye, but decrease the insulating value very little.

AMATEUR SOUND MOVIES

S QUND equipment for amateur move baddiets, available for some years, has made use of the regular film sound track which, of course, necessitates the use of photoe-lecture cells and survivary quapment. Now, for the first time, anateur movies quapment. Now, for the first time, anateur movies quapment disalgage, many, and sound offects—all reproduced as perfectly as sound on film but the use of a phonograph dask in the Svacrosound System, a product of Presto Recording Corporation

The entire soul recording and repretable the soul recording and repreciation of the soul recording and an angle carrying case that weighs less than \$50 pounds. It can readily be carried by one man. The cost of the equipment is about 1/10th as much as the lowest priced sound on-film equipment. The cost of the sound coordings themselves averages about 20 cents a minute of running time, or one doil lar for a five-minute reel. The weight-rounds tion is automatic, requiring no supervision or adjustment once the preture is started

The sound recording and reproducing system can be added to any stendard make of silent 8 or 16mm camera and projector 11 consists of a portable sound recorder, an electric motor drive for the camera, and a small attachment for the projector The latter units can be installed for a few dol lars and they can be quickly detached if desired to make silent filias.

SLOW FUSE

ELECTRIC motors, coils, solenoids, mag nets, and relays often have overloads which are not necessarily harmful but which, nevertheless, blow the ordinary type



Welding the double tube of the Chicago River tunnel

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In former years, the collection of the best work of American photographer—reproduced by fine gravite printing—was enough to vin acclaim from hundreds of book reviewers and act critical in provided impiration and guidance for thousands of photographs But, never content with pest achievaments, Editor T. J. Malonay this year saided marry new features to increase the value.

Finer Printing, Better Binding

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cases, ortisance and tones variations of the original salon prints are preserved then possible by any other printing method.

Second new feature is an improved binding that makes U. S. Camera a more beautiful, lasting addition to your library than aver before—and at no change in price!

More Articles, More Inspiration

Third big feature is its editorial contants this year it is more than a salon-in-book-form It bas more fine pictures than ever before, but in addition it has more written and edite then ever before! It is a book to read and study, as well as book to fook at

SUMMARY OF CONTENTS

Here is a partial list of features of U. S. Camera

Over 250 pages containing basutiful reproductions of the 300 greatest pictures of the year.

Edward Staichan, sole judge, also contributes a simulating commentary on Photography today.

Edward Weston's Guggenheim Portfono: a twenty-four page section entirely devoted to Bdward Weston's famous Californie photographs. Mr. Weston also writes a fascinating description of how this monumental work was dona, the resoning back of it, and the problems involved!

Hundred Year's of Photography by Elizabeth

tographic subjects traces the contributions of this exciting art—not in tarms of its early phases but its place in the contemporary American scans

tte place in the contemporary Amarican scana

Bigger Color Section Better than ever this
year because of the improvement in color tech
inqua. Bigger, too; full page reproductions from
fine process plates, of the work of America's lead
ing color photographers.

Greatly Enlarged Date Section Still more complete date on exactly how each picture was made with all equipment listed, and this year begraph red and personal date on the photographer himself!

Spacial Features 1939's outstanding newspictures Groupings of unique teature photo graphs contrasts and humor shots breathtaking serial panorames amazing ail antific photographs documentary pictures portests and percorisis, nudes and illustrations that axexis, entertain and stimulating

tions that acctae, enserten and simulated Reserve your copy index / Let year's edition was animaly sold in a few weeks. So avoid now you will want it for consaint assement during the year—and for years to come [Remember. by wellable]. And desprise after her well string the year of the read of

U. S. CAMERA MAGAZINE

A SOLID YEAR OF PHOTOGRAPHIC INSPIRATION AND INSTRUCTION AT VERY LOW COST.

Would you like Ansal Adams to tall you how to photograph Architectura, Illustrating his points with a serias of magnificent prints of a California ranch-bouse?

Would you like to hear about Paul Strend's work and photographic philosophy from Elizabeth McCauslend?

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Would you like to see the scores of prize-win ning pictures from the many thousands entered in the U.S. Camera Magazine Competition?

Would you like to know how Barbers Morgan photographs the modern dence? How Elliot Elisofon does his documentary pictures?

Art Center School of Los Angeles works?

Would you like to know more shout the work of Lessren, Hiller, Affred Steightts, Martin Munkacs, Valentino Serra, Elliot Portar, Margaret Bourks White, and dozans of others?

Many Exciting Features

These are just a few of the features in coming issues of U S Camera Maganne—America's continuat and most excining photographs, publication As it enters its second year, now firmly similarities to the front rank, this embirous maganne intends to make asch issue bigger, more instructive and simulating that pravious issues

Giving Readers What They Want

In the next six big issues of U S Camers you will see a more thrilling collection of analysical stricks, simulating commentaries on photography's piece in the sun, pretaze—sacrifing,—than you've aver rand or rean before Thing,—than you've aver rand or rean before Thing by and shout knowns and unknowns, amateurs and pros, but they'll all he good.

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of fuse so that service is interrupted while new fuses are put in place A new fuse, recently developed by Littleliue Incorporated, is of unique construction, designed particularly to prevent such interruptions it has a simple fuse link, a resistor element which provides the heat inertia, or time lag, and a spring

On severe overloads, the fuse link melis as a convential fuse would do, on prolonged but not severe overloads, the resistor heats up and melis the fusible alloy. The spring serves not only to open the circuit completely after the fusible link has melted, but also takes up the expansion of that link due to repeated heating and cooling.

SHOULD EXPECTANT MOTHERS SMOKE?

S MOKING does not have any good effects on the mother during pregnancy However, climical experience would indicate that a moderate use of tobacco is not harmful to the mother or to the baby. When a woman smokes excessively, it is usually suggested that she decrease her smoking during pregnancy and particularly during the nirsing period.

Many physicians feel that the nicotine in tobacco may have a deleterious effect on the baby, but there is little scientific evidence to substantiate this view. Nicotine, however, does pass through into the mother's milk, so that excessive smoking may result in toxic amounts of nicotine being absorbed by the child.—Journal of the American Medical Association.

ILLUMINATED TRAFFIC MARKER SET INTO HIGHWAY

O F the numerous attempts that have been made to provide safety markers for lughtways for night driving, one that seems to provide more positive illumination than any other so far deresed is that definition of the control of the control of the control of illuminated founds. Inc., Inc., Ihis invention consists of a neon or other tubular light buried in the roadway under a transparent uncertail. Such lights would be built into roadways at important intersections, turns, or other danger spots, and it is believed that no amount of fog or glare from approaching arrs would prevent their boung seen hy a

When Mr Greene first conceived this idea he consulted with a number of people regarding a transparent material which would stand traffic wear Some people told him the scheme was impractical, but he finally found that a transparent plastic would withstand not only the weight but also the surface wearing effect of passing cars and trucks. In accompanying illustrations we

Above: One unit of the illuminated traffic marker. Below A plastic test block set in a busy highway



show a sample unt of the illuminated guide ine and also a picture of a test block of a plastic material made by Monanto Chemcal Company which was set in a busy street of Little Rock, Arkansas, for nunmonths. At the end of that time, during which an average of 9000 cars per day passed over it, the plastic substance showed on apparent depreciation of the surface and it ransparency was as good as when the

SCIENCE TO THE AID OF

N OT all inventions are made with a definite use in mind Only too often one may result from a great amount of research and then much more research is necessary to find what it is good for Polarioid, a material which polarizes light, falls in exactly that class. Originally, it was con-

sidered for an important use in the headlights of cars to which it has not as yet been adspted. It had, of course, a definite place from the beginning in scientific work, but practical everyday applications had to be found for it. Work to that end has found for it a place in many industries.

It may, therefore, not be so surprising to learn that this rapidly growing invention has been adapted for the beauty parlor Because of the ability of this material to dampen light reflections, as we have explained before in these columns, it has been found to be an excellent medium through which to view the skin and see those blemishes which are partly or wholly invisible under ordinary light. Dr. Martin Grabau recently demonstrated in the salon of Helena Rubenstein what is called the "Po-laroid Dermascope," which employs this material. With it, it is claimed that an ohserver can examine layers of skin under the epidermis almost as though the outer skin surface were not there. Then by moving a control lever, he can throw the outer surface into even greater prominence than under ordinary light for the examination of surface blemishes. The assumption is that once the beauty specialist knows of the existence of hitherto unseen blemishes she can adapt her procedure accordingly!

PRESERVING PAPER

A NEW and improved method of protect by Dr Joseph Broadman, will attengthen paper by means of a protective coating which renders the aliest impermeable to air, moisture, and the like, so that it can be handled and preserved indefinitely. The coating does not increase reading difficulty.

In this process, a page of a newspaper, for cample, has fixed to each face at hin sheet of transparent paper, preferably of that type known in the trade as "glassine". These sheets of light-permeable paper at laid on the newspaper with any untable atheave, preferably a past of cold water and wheat four. They are then allowed to dry at ordinary noom temperature. The sheets of transparent paper increase the attempth



"Polaroid Dermacope" and, top, skin under ordinary light (left) and polarised light

and tearing resistance of the newspaper, so that it can be handled without crumbling. But the transparent paper alone will not protect the page from the effects of air, moisture, and age, so the Broadman Process provides a coating on both faces and the edges of the transparent paper covered sheet, thus hermetically sealing the printed or written matter against deterioration.

The protective coating is a composition consisting of a mixture of 25 parts of Maula gum or Manila copal and 75 parts of chaptal alcohol. East India or Pontinane gums may be substituted in the same proportion. The coating is applied by means of a rigid pad or spreading tool or perforated roller with a cloth covering, causing the formation of a leth-termeable, smooth coating.

If has been estimated that about two or three seconds are required to add the "preserving" coating to a coated double page of standard newspaper size, at a cost of 12 cents pur sheet. The entire process, including transparent paper and adhesive naternal, less than doubles the weight and thickness of the page of newspaper.—Shatley Frank

GROUP STUDY OF X RAYS

THE Westinghouse multi-view stereofunctional X-ray pictures to be viewed by groups of two to eight persons at a time Pol.-r.red light also is applied to X ray work for the first time in X-ray history by the multi-view stereoscope. The old-fash-



Multi-view stereoscope, in which X rays appear in three dimensions

loads atteroption which used to adomthe pation in the average American bone to the pation in the sevange American bone copy work in medicine and industry. The creation of a picture effect which above depth depends upon the presentation of two images, taken from alightly different view-points. Each eye must inspect only that image intended for it. This is usually accomplished by means of micrors or prisms. The polarized atteroscope employs two images or transparencies made in the usual manner. The method of illumination and impaction of the images, however, is new.

images or transparencies made in the usual manner. The method of illumination and inspection of the images, however, is new, axising from an interesting property of light. Two films are placed in illuminator boxes, et a right angles to each other, and ditted with Polucuid access. One illuminator has its access arranged to produce vertical polarization: the other, horizontal polarization: the other, horizontal polarization: the other, horizontal polarization; the other, horizontal polarization; the other, horizontal polarization and the polarization and the polarization and the other horizontal polarization.

From tough steerto TENDER STEAK

by Westinghouse



- When a friend unexpectedly happens to drop in for dinner, it no more than right that he take potluck for granted. But when we carefully plan a dinner, long in advance, most of us pretty much stick to the rule of serving the best food we can get.
- That rule was rudely broken last April, when one hundred and forty-six people sat down to dinner at a Cleveland hotel. It was a notable group—civic and industrial leaders, food experts, home economists, chefs, editors—people invited for one particular purpose, to taste a new kind of steak.
- They were not served choice beef; those steaks were not expensive. Average in quality, average in price, average in every respect—but one! This beef was treated by a new process, called Tenderay, which has the peculiar ability of making ordinary beef as tender and juicy in just three days as the expensive cuts the very finest hotels serve after three or four or five weeks' aging.
- The guests were delighted. The steaks, they said, were excellent. But they were not half as pleased as Mrs. Cleveland housewife who learned that from that day on she could buy the same kind of beef at her own store. Heard that for the

- first time she could buy steak without guess and without gamble and know that it would be tender always.
- The Tenderay process depends on a lot of factors; humidity, temperature and what not. BUT—and here is where Westinghouse research plays such an important part—the process would be utterly impractical without the newly perfected *Sterilamp which kills bacteria with light and keeps the meat fresh and sweet.
- · He would be a rash prophet who'd care to predict the uses commerce and industry and medicine will find for the Sterilamp. In Suffern, N. Y., a bank installed it over the teller's windows to keep germs from passing with the money. A poultry man says it solves his turkey raising problems, Restaurants, hotels, bars and soda-fountains-in ever increasing numbers-depend on Sterilamps to keep glasses sterile; meat markets and groceries to keep food fresh, to reduce spoilage and refrigeration costs. One of the country's largest hospitals has installed Sterilamps to sterilize the air in the operating rooms. Another in the nursery to protect babies in their
- Certainly Westinghouse, when this development started, did not know its ultimate scope. And that, after all, is the way of research and its great justification. It is an exploration into the unknown, it follows new paths and uncharted byways—not with the assurance of success; merely with courage and experience and knowledge, and sound common sense as a guide.

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a diagonal midway between the illuminator boxes. Each observer looks through a pair of polarizing spectacles. Looking into the semi-transparent mirror, the persons at the left see one image reflected in the mirror. the other transmitted through it. Each eye sees only the image intended for it and each with the same brilliance. The new apparatus permits a group to discuss the same image. at the same time that they are viewing it

ELECTROPLATING

PLASTICS

ELECTRO-DEPOSITION of various types of synthetic resinous materials on metals by a new process was described in a recent issue of Industrial and Engineering Chemistry. The process involves the solution of the resin in an organic solvent and the subsequent formation of a suspeneion in mineral oil

The work to be plated, which may be copper, tin, or brass, is placed in the suspension and direct current applied. Satisfactory results were obtained, using 300 volts for five minutes. After the plating has been applied, the plastic is cured or not, depending on the type Tests showed that the deposits are satisfactory from the stand point of electrical insulation. The process has been used experimentally for coating small trimmer condenser places.

RIINA

GERMANY is equipped to manu-facture about 25,000 tons of artificial rubber yearly, as comp with a peace-time need of 100,000 tone of rubber per year.

REFRIGERATION

AFFECTS FLAVOR

REFRIGERATION of many fruits and vegetables, as housewives have often complained, destroys the rich, delicate flavor for which those products may be noted. This is particularly true of tropical fruits such as bananas, pineapples, mangoes, and avocados. It is also true to some extent and avorages. It is also true to some extent for fruits grown in the temperate zones. Some varieties of pears, if held too long at 32 degrees, lose their ability to ripen and "go dead."

To prevent loss of flavor and texture, tropical fruits and pears should not be chilled until immediately before serving.

CIRCULAR SEAM WELDING

AN engineering advance has recently been made by the Chicago Metal Hose Corporation in the attachment of metal end-fittings and end-seals to metallic tubing by means of electric resistance welding. This means or execute resssance welding. This development, designed principally for use with stainless steel tubing and stainless steel bellows, permits the fabrication of completely sealed vacuum-right units free from soldered, brazed, or torch welded ioning of each brazed, or torch welded joints of any kind.

End fittings made from stainless steel have been customarily silver soldered to stainless bellows and tubing where corresive media or high temperature were to be encountered. However, to meet conditions

where exceptionally high temperatures and actively corrosive elements preclude even the use of silver solder, electric resistance welding has unique application.

Circumference seam welding, made possible through the development of specialized equipment, operates automatically and eliminates entirely the human element present in other welding or soldernel procedures. Extremely thin gages of metal can be handled with ease, and metals of unlike thicknesses or unlike analyses can readily be ioned.

TRANSPARENT PLASTIC HEEL

A NEW plastic heel is now available in sides list transparency, it has the novel feature of a removable hit. As the lift wears down, it may be taken off sud a new one snapped into place. The heel is a product of the General Electric Company's plastics division.

The accompanying picture is of a transparent model showing the construction. A



plastic of the polyvinyl methacrylate type is used for the heels. They are waterproof, noninflammable, and give a touch of sparkle to almost any costume.

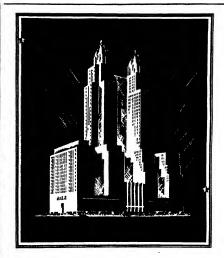
Some of the heels were "neonized" recently for stage use by the St Louis Minneipal Opera. They produced a striking effect on a darkened stage.

ACID HEALS PLANT WOUNDS

WOUNDS in plants are caused to heal by an acid which has been solated in crystalline form by research workers of the California Institute of Technology. The mane "traumatic acid" was proposed for the substance which is identical with the companic acid. Accessed, 1946-ashroysis of the california of the control of the con

FROZEN SERUM

LiQUID biologicals, those therapeutic agents derived from living sources, have always had a time limit on their original value. This is the reason for the expiration date placed on each market package. A recently amnounced process, however, en-



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The containers are specially designed to maintain the desired vacuum and are so constructed that into the neck of each there may be inserted a tightly fitting rubber stopper. This is done after dehydration is completed and without breaking the vacuum When the stoppers are in place, the containers are flame sealed, labelled, and are ready for shipment.

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The new process brings to the physician, and ultimately to the patient, the original curative value possessed by a freshly pre-pared substance at the time of its highest notency.

AIR CONDITIONING

N 1933, there were only about 40 air-conditioned passenger cars on the American railroads, and most of them were diners. Today, the railroads and the Pullman Company operate 11,351 sir-conditioned passenger cars.

BIG OIL MOLECULES

FROM SMALL

SQUADRONS of German fighting and bombing planes now flying in Europe's skies are being lubricated by oils made by treating mineral, vegetable, and animal oils with an electrical discharge process which increases their viscosity. The "voltolized" oils, as they are known, are then blended with ordinary mineral oils to pro-duce what is said to be a superior airplane lubricant which has many of the valuable properties of castor oil.

The action of the electrical discharge appears to produce polymerization of the molecules of the oil (make large molecules out of small ones) and does it without changing the essential properties which make for good lubrication .- Science Service.

NEW TYPE BIG TREE

MOVER

BIG tree moving is now an established practice in landscaping properties and it is only natural that labor-saving equipit is only factivate that infor-saving equipment has been devised to keep costs lowered and generally to increase the speed and efficiency with which large specimen trees may be moved and transplanted.

Over a period of the last 10 years, an

eficient type of tree-moring equipment known as the Buts Tree Mover has been developed under extensive field tests. It is compact, requires less hand labor, is readily mobile, and bandles trees with speed and safety. Constructed of electrically welded seed and with all fast-moving parts equipped with ball or relier bearings, it should give years of dependable, troublefree service.

The equipment consists of a complete unit which can be installed on any truck baving a minimum of nine inches from rear spring shackles to back of cab. It is so designed that the cradle, in which rests the trunk of the tree to be moved, pivots in two directions, this factor, together with



Cradle end of the unit employed for transporting large live trees

chain suspension, insures proper support for any size or shape of tree. A second cradle, adjustable both in size and in its relation to the trunk cradle, is attached to the rear of the boom, supporting and protecting the ball of earth which may be up to 10 feet in diameter. The boom rolls on its hinges and is lowered to ground for loading. When transporting the tree, the boom is carried up and forward by a power winch driven by a 15,000-pound worin drive. An eyebolt, attached through an adjusting winch to top of boom by cables which pass on each side of the tree, is placed through the ball of earth and affixed to a horizontal plank underneath. The cables in turn are connected to a heavyduty canvas belt behind the tree trunk to simplify tipping and guiding of the tree.

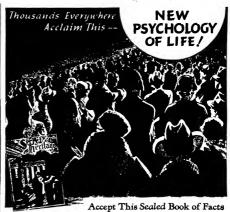
Carried in a horizontal position with the top forward, the tree resis on saddles at each end of the boom. This latter is operated by roller chain and worm driven sprockets, which control tipping of the boom downward and a leverage, powered by the same roller chains, controls upward tipping of the boom.

The Butts Tree Mover is also used in

The Butts Tree Mover is also used in pulling and loading stumps and is well adapted for use on many kinds of construction jobs.—C. F. Greeves-Carpenter.

NEW SYNTHETIC SOLID PRODUCES UNUSUAL TRACING PAPER

AN entirely new type of tracing paper A combining the transparency of oil treated sheets with the permanence of natural 100-percent zag papers is a recent newledgement of the Keuffel & Seer Company. The new paper is named Albannea. It is made of long-fiber, clean, white rags, and is treated with a new crystal-clear synthesis could make the company's taboratories. Bocause this new transparenting agent is free from oil



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and wax and is chemically and physically inert, it is claimed that Albanene will not oxidize, turn yellow, become brittle, or lose transparency with age.

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RAILS

RY using a welding process for BY using a welding process for building up the worn ends of steel rails, the life of these rails is prolonged fully one third.

PROTECTING COPPER SURFACES

THE New York World's Fair, besides being an extraordinary speciacle, proved to be a testing ground to show the lasting qualities of paints, colors, and protecting contings. Of particular interest is the use of Glyptal, an alkyd resin, which has proved its ability to maintain the luster and characteristic color of copper sheets which it protects. On the exterior of the General Electric Building are thousands of square feet of thin copper sheets, protected with a coating of this material, which have retained their pristine appearance during many months of exposure. This first actual long-term test of Glyptal under such conditions indicates many other possibilities for its use in many industries.

ELECTRIC FURNACE USES BLANKET OF GAS

R ESEARCH metallurgists have intro-duced a new steel-hardening furnace that uses a "blanket" of gas to prevent "singeing" the metal while it is toughened at temperatures as high as 2000 degrees, Fahrenheit.

By means of a delicately balanced atmosphere of pure hydrogen and nitrogen, this automatic electric furnace is able to harden many steels gently without quenching them in oil or water, thus channeling distortion and formation of scale.

The furnace is approximately seven feet



Removing a block of air-hardened steel from best-treating furnace

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Air-hardened steel scratches glass,

long and so designed that a piece of steel passes through it at varying stages of heat, ranging from approximately 1300 degrees to 1750 degrees, Fahrenheit, before it cools in an air-cooled tunnel. Maintenance of atmosphere of oxygen-free gases inside the furnace prevents any reaction in the steel which would distort or mar the metal. The steel shows no outward evidence of having passed through the fiery ordeal.

Pieces of ordinary steel, polished to a mirror finish, retain their finish after a fourhour hardening treatment in the new apparatus, report Westinghouse engineers The same steel would burn up if it were subjected to such high temperatures in an ordinary furnace, because of the oxygen in the atmosphere.

The combination of controlled atmosphere and temperature now enables the metallurgist to harden steel pieces in their finished form with a resultant bright finish and without the expense and delay of additional machining.

INCREASING THE BEARING CAPACITY OF PILES

RECENT investigations for the purpose of economizing pile foundations have developed an interesting method for increasing the bearing capacity of piles by covering them with a thin sheet of aluminum metal and sending an electric current through the soil. Preliminary small-scale tests performed revealed the formation of an entirely new and hardened soil structure in the vicinity of the electrodes. Tests also revealed that the hardening is not simply a drying of soil, but is irreversible since aluminum compounds are precipitated in the soil by the electrical process, cementing the mineral particles of the soil.

With small-scale tests, the bearing capacity after treatment increased up to between 10 and 30 times the original. By pulling the piles, the hardened section around the electrodes can easily be seen. Large-scale tests encouraged a practical application at a bridge foundation. A few timber piles about 60 feet long were covered up to about 25 feet with thin aluminum and driven under similar conditions in the near vicinity of common piles without aluminum. The distance apart of the aluminum piles was between six and seven feet, and electric curreni was sent through at between 90 and 220 volts. Though the subsoil conditions



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Write for Free Literature PHOTOBELL CORP. Dept. 57, 123 Liberty St. were not very favorable for application of this method, the hearing capacity rose from an average of 70 tons to an average of 200 tons after treatment.—Dr. Lee Casagrands, in Bulletin No. 11, The Institution of Highway Engineers (England).

ATR

IF sir were sold for twelve cents a quart, it would cost each of us over \$2000 a day to breathe, and the rmer would have to pay ever \$13,000,000 a day for the air to raise an acre of wheat,

AERIAL MAPPING FOR HIGHWAYS

THE fastest and cheapest way to secure an inventory of any area is to have it photographed from the air. With highway planning now covering whole states and requiring more and more inventory data, modern methods of mapping based on aerial photography have recently been developed to permit economic methods through the use of simple instruments and devices.

In making topographic maps by stereoscopic methods, the camera used for aerial photographs is of the precision type. Flying is done systematically so that the required overlays, both in the direction of flight and sideways, will be consistent. An aerial photograph does not show any depth, but with two photos partly overlapping and taken from different positions, it is possible to adjust them on the table at a certain distance from the eyes so that there are two images which merge into one having depth in addition to previous characteristies. To aid in viewing, a stereoscope is used.

Where the nature of a contemplated project involves the purchase of land, it is safe to say that the mapping of property hy this method on a scale of 1:12,000 is just as accurate as if the surveys were made by transit and tape plotted to this scale.-Eric Haquinus, in the Texas Engineer.

TRICHINAE IN AMERICAN SWINE

TRICHINAE, the muscle-boring para-sites that cause painful and occasionally fatal illness in enters of inadequately cooked pork, are widely distributed in the United States, reports Dr. Benjamin Schwartz of the U. S. Department of Agrieulture. In grain-fed swine, however, they are not nearly as abundant as in those fed on garbage. On the basis of thousands of examinations of slaughtered animals, Dr. Schwartz gave the percentage of trichinae-eontaining carcasses as less than 1 for graincommining cercases as less than 1 for grain-fied hogs, whereas it was 5.7 percent in garbage-fed hogs. The greatest bulk of hogs slaughtered in the United States, Dr. Schwartz added, are grain-fed.—Science Service.

WHEN RUBBER OUT-LASTS STEEL

A RUBBER spring can now be made to outlest even a steel spring, it was declared by Dr. S. M. Cadwell, in a paper

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SOLUTION TO THE PROBLEM OF THE WEIGHTS

AST month the problem offered was one concerning a set of eight weights for use with a beam balance. The weights were to be capable of weighing to the nearest ounce any object up to, and including, 205 pounds. Each could be used on the left scale pan, on the right, or not at all. It was required to find the magnitude of each weight, prove that eight is the least number, and that the eight weights have the least total weight of any set which will ful-

fill the conditions of the problem. Solving for the first part we reason that, ta weigh one ounce, it is necessary to have a 1 oz. weight In order to weigh two ounces we may select an additional I oz weight, a 2 oz. weight, or a 3 oz weight. We choose the 3 oz., because together with the 1 oz. weight it will enable us to weigh not only 2 oz., but 3 oz. and 4 oz as well Similarly, in order to weigh 5 ounces, we select a weight equel to two times the sum of the weights alreedy chosen, plus one For example, (2) (4) + 1 = 9 oz Reasoning thus, it follows that the right weights are 1, 3, 9, 27, 81, 243, 729, and 2187 ounces; a total of 3280 ounces, or 205 pounds Solving for the second part, we see that

since there are three places where the weights may be placed, there will be 3' different distributions of them From this number we subtract one to account for the case where all weights are on the shelf. The remeinder is divided by two because for each "out of balance" on the left side there is one on the right. This evaluates to $\frac{3^{2}-1}{2} = \frac{6561-1}{2} = 3280$

$$\frac{3^{4}-1}{2} = \frac{6561-1}{2} = 3280$$

It is apparent from the nature of the formula that a number smaller than eight for the exponent of three will give fewer than 3280 weighing combinations, which was a con-dition of the problem Eight is therefore the least number of weights.

For the third part of the problem, obviouely it requires a minimum of 205 pounds to weigh that much on a beam balance. Since the eight weights add up to only that amount, it follows that they have the least total weight of any set which will meet the conditions of the problem.

resented before a meeting of the American Chemical Society. Dr. Cadwell is director of tire development at the Detroit plant of United States Rubber Company

This somewhat astonishing conclusion is the result of a series of scientific tests and a research over the past three years in the company's laboratories, Dr. Cadwell re-The scientist was reserved in his report and comment, but other researchers pointed out that the discovery had possi-bilities of great importance to industry and

Dr. Cadwell told the Society his conclusion rested on the remarkable fact that rubber differs from most, if not all, other natural materials in that the "harder rubber is worked the greater its mechanical fatigue

"Indeed," he reported, "if rubber is used properly as a spring it can be made even to outlast a steel spring. If metals are to be worked in vibration, all engineers know that the longest life can be expected for a unit in which the metal is under minimum stress or load. For rubher, the opposite is true; the shortest life occurs when the rubber is worked under low loading or low stress conditions.

LOW-TEMPERATURE FIRING FOR NEW

CERAMIC MATERIAL

THE high cost and hazard of kiln firing. which often discourage ceramic and pottery work as a hobby, school craft, or small commercial venture, have been banished by the development of a new cley by Ettl Studios, Inc Ceramite, as this clay is called, requires no treatment other than baking in a kitchen oven for 20 minutes at 250 degrees, Fahrenheit, to produce a product having greater durability than ordinary clay fired at 1800 degrees.

Also available is a full line of color glazes which can be applied with a brush or spray, blended or applied over each other, and rendered permanent by oven haking for 45 minutes at 250 degrees, Fahrenheit.

PROBLEM: THE SWIMMING DOG

OR the past few months we have been FOR the past few months we have been offering our readers a variety of mathe matical problems. Judging from the letters received, many people have really enjoyed wrestling with them. There seems to be a sort of esoteric satisfaction in arriving at a solution after an hour or so of brain work Can you solve this one?

A man is standing on a river bank, on the opposite hank is his dog. The man whistles and the dog, being well trained and very ohedient, jumps into the river and starts swimming, always headed towards his master. The man is represented by "O" in our diagram, and the dog's starting point by



"P." The river is 0.48 miles wide and the dog started from a place 0.14 miles below point directly opposite the man. (In other words, the man and his dog were a half mile apart.) Now, if the river flows at a rate of one mile per hour and the dog swims at the rate of two miles per hour, how long will it take him to awim the river? Remember that at all times he is swimming towards point "O". The answer is 22.8 minutes and we will publish our solution next month.

As usual, any correspondence relative to this or any of our previous problems should be addressed to Lieutenant-Commander Leonard Kaplan, in care of Scientific American, 24 West 40 St., New York, N. Y., and it will be forwarded unopened.



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YOUR FIREARMS

Conducted by A. D. RATHBONE, IV

INTEREST IN FIREARMS is traditional with American men; science has so developed them that millions yearly find sport and recreation in their use. Hence this monthly department presenting a while variety of divension regarding frearms, their handling, and their accessories. Suggestions from readers will be heartly welcomed.—The Editor.

TENITE STOCKS

WHETHER or not we've all been aware of it, this stuff called Tenire has been with us in many ways for some time. Both hands have clasped it as we've gropped the hands have clasped it as we've gropped the in the property of
something of a str in firearms circles. Product of Tennessee Eastiman Corporation, Tentie is made from Eastman collosies acetate, as thermoplastic and adaptable to both compression and injection molding, its attributes for gun stock are low thermal conductivity, low water absorption, compressive attempts of about 4000 pounds per square inch. In conducting fing tests, a Tentie stocked shotgen was clamped in a shooting pack, shoulder price resumg against a solid block so that the solid fring, the hard tubber butt-plate crumbled from constant hammering, while the plastic stock showed no fracture or distortion.

Shortly after the Stevens announcement, criticism was leveled at the alleged shrinking tendency of Tenite when exposed to a maintained temperature of 140 degrees, Fahrenheit. It was likewise charged that Tenite would soften and possibly warp in a continuous heat of 160 degrees, Fahrenheit, that acid or alcohol might blemish or soften the smooth, walnut burl-like finish. Although disapprobation was also expressed concerning stock measurements, we're momentarily more interested in the shility of Tenite to "take it" than in gun specifications. However, here's how Stevens lists them gun 14 available in 12, 16 and 20 gage with blue forged steel barrels, matted rib, fitted with two white bead Colasta sights, in 28 and 30 inches for 12 gage, 28 Inches in 16 and 20 gage. Right barrel is modified and left is full choke, chambered for 2%-inch shells. It is hammerless; has checkered, full-pistol grip, capped; fluted comb; paneled sides; 14 inch stock; drop at heel of 2%, at comb 15% inches; positive extraction; and weighs from 6½ pounds in 20 gage to 7½ pounds in 12 gage.

In 12 gage.

To determine effects of chemicals and reagents on Tenite, Tennessee Eastman Corporation conducted a series of tests in which dried, weighed, and measured

samples of the plastic were immersed for 84 hours in 85 directs acids, slabels, slist, alcohols, organic exters, solvents, essential solution, and macefulaneous chemicals of varying solution strengths. From this list we endeavored to select those regents to which a gun stock might normally be expected to be exposed in the gamist of carriess human actions, climinating such unlikely hazards as hydrochlora acid, solution hydroxide, and selection of the selection o



Stock, fore-end, and sight piece of a new shotgun are of Tenite

lemon, pennyroyal, and wintergreen, concerning which Eastman texts showed that henzene produces a "slight blustering," oil of wintergreen a "slightly rough surface," sodine a "brown timt," mercurochtome s "pink timt." Otherwise, "no change" was reported in the surface of Tente after exposure to these reagents which we selected from the entire 55.

Not doubting the Eastman laboratories, but solely in an effort to test Tenite with both reagents and vicissitudes to which an extremely careless gunner might uninten tionally expose his gunstock, we conducted a few "home-made" experiments. We procured samples of the plastic and smacked one piece with a hammer to simulate a hard fall or a blow of the stock against trees and rocks. The result was a much smaller dent than the same force would have made in a piece of walnut. We sacrificed a bit of 90-proof whisky in a 24-hour immersion test without effecting the slightest blemish. Lemon juice, gasoline, iodine, mercurochrome were all negative, save for the expected stains from the latter two reagents. We laid a lighted cigarette on a slab of Tenite and allowed it to burn to the end. The result was exactly what we've been chastleed for in the instances of the piano and the drop-leaf table.

As to the danger of a maintained temperature of 160 degrees, Fahrenheit, Frank T Green, Assistant Superintendent of the Stevens Company says, "... among our laboratory tests, we subjected a stock molded from this material (Tenito), to a set in a closed electrical over where tenperatures could be maintained consant for a long period of time, and we were able to subject these stocks to a temperature of from 100 to 200 degree, Fabrendeit, without any apparent distortion." We shudder to think that any person could conceivably do to his gunstock all that was done to Tenne and we rather think that, moder as its durable qualities are concerned, the results speak for themselves.

FOR GUN COLLECTORS

TTS a far cry, indeed, from a Tenite anocked shotgun of the 20th Century to the Austran made specimen of wheel-heel "sporting full" of 1655 when we recently imported at the exhibit of the International Studio Art Corporation, formerly a part of the William Randolph Hearst collection, and now being disposed of Speciations of this infe, expressed in the modern maner, are; blued, ordigonal barrel; fixed leaf rear sight for point blank shooting with adjustable folding leaf for elevation (fancy that—"elevation" in 16651); rifled with eight, deep, narrow growers; length, 44 inches, weight, 8 pounds, 541 ounces, caliber, A3

Not to know where or when one massumble aerose a really fine specimen of the early gunsmith's art, but to be able to evaluate such a find, and to couple with it all an active imagination, probably constitute the primary couponent parts of the fascinating hobby of anisteur antique gun collecting. Our own imagination certainly needed no urging when, in runninging needed no urging when, in runninging strong the part of ducling pustols which we found the pair of ducling pustols which spat lead at each ofter on Startidy immoring, April 28, 1826. For on that date, with those arms, at a secluded upon above Little those arms, at a secluded upon above Little



Dueling pistols that were used on the field of honor 113 years ago

Falls Bridge, Virginia, John Randolph and Henry Clay respectively sought and delended honor. No one was hurt, homor was vindicated, dueling went the way of the muzzle loader, and now, 13 years later, thus fine pair of pistols is booking for a new owner. Meanwhile, our imagenation ranbles on in the realm of ancient firearms and those who used them.

We've considerable interesting information on tap concerning the inauguration of amateur collections of old firearms and if you're interested in learning how to begin, where and what to look for, we'll be only too glad to pass it on.

EUROPEAN GUNS

AVAILABLE

NO one can prophesy what new twists the European war will have taken by the time this appears in print, but we have recently been informed by Abercrome be & Fitch, Franse Bannerman & Sons, and Stoeger Arms Corporation, three of our largest importers of foreign made sportsmen's arms, that the importation of those very excellent Belgam and English abottums and riles has not thus far been serously affected. Save for the German market, where the situation is, rather naturally, somewhat different, imports are expected to the international content of the content of the company of the content of t

Although all British gun manufacturers are reported to be busily engaged in wartime operations, and although their pers nel has been affected by calls to the colors, Messrs James Purdy & Sons, Boss & Company, E J Churchill, Ltd , W. W Greener, James Woodward & Sons, and others are continuing to make the fine quality guns for which they have so long been fam There has been no perceptible break in the import of Belgian firearms and save for a momentary hill at the outbreak of the war, British imports have to date proceeded normally. Despite the discription of German slupping, Abererombie & Fitch have just reported the receipt of a shipment, via

Pot-Shots

AT THINGS NEW

Rust Institutive Products suggest use of RIG for rifles, pivols, and alsogams to prevent crosson, ocrosson, wear from brushes, patches, and abrasives and for proiection of the decheate surface of the bore-RIG's use is not limited to guns; it is highly recommended for skates, fishing tackle, and tools, and it goes hand-in-hand with RIO, a rest inhibiting of

BOOKS OF THE MOMENT include Ledyard Sands' "The Bird, the Gun, and the Dog" and Bob Nichols' "Skeet And How To Shoot It," reviewed on other pages of this ISSUE.

Prass-To Oilen, product of the Dill Manufacturing Go, looks like a fountain pen, elips into the pocket like one, has a transparent oil reservoir, and applies exactly the right amount of oil ni pust the spot where you want it. Each press on the steel point releases 1/10 of a drop of oil with no dripping or smearing.

REMINISTON ARMS Co., in attractive threecolor trap and skeet catalog, prevents complete line of traps, tuners, new crump shells, guns, targets and full dimensional and working plans for skeet field lay-out and traphouses.

Ivan Joutsoon's latest addition to 22 target rewiver field is Model 822. Specifications, including proof-testing and sighting, are: single action; adjustable finger rest; blued finath, 8 shots; counter-borred chambers and extractor; six-nuch barrel with non-plare rul; Patringle type sights; oneprece variant checkwerd grap; highly pollated seried hammed length, 10%, mehrebody and the property of the property of Model 822 shoots 122 calable long; file, long, and short rim fire, is not equipped with "Hammer whethers"



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THOSE VACATION

PICTURES

THE vacation months are gone but the negatives remain, and with them your responsibility for carefully evaluating the merits of each and discarding those which, from every viewpoint, are of no worth. Among the discards will undoubtedly be sunrises and sunsets, mountain scenes with bald skies, certain landscapes, and so on. Even the best of us, carried away by a peculiar lighting or misled by a touch of color which might have been effective in color but not in black and white, take a number of shots during our vacations and at other times which bring disappointing results when fished out of the developer tank Such incidents are nuggets of expersence which are to be valued rather than deplored. The next time you will be more careful and hold your fire, or try some other angle.

Among your most interesting negatives will be those of people, particularly children. Some of them, because you may possibly have had to work fast and get your subject on the fly or were handcapped in some other way, may not be everything that might be desured as to composition. However, do not give up on this account; there is always the opportunity of taking a piece out of the negative and projecting it at a suitable angle. The "Rural Portraut" illustration did not present any great difficulty with this group of eight children of vanous ages. The slow owas conveniently handy;

the lighting would have been better if the faces were more in the shade, but the squints here and there lend an atmosphere of humor to the picture.

Valued above others will probably be those pettires which illustrate your vacation experiences. An entire series or group of prints may be assembled to illustrate the experiences of living as a farmhouse in the country. One such pieture is that of "Sunrise" taken at 6:30 o'clock on a September morning. In composing this pieture in the camera, it was thought best to concentrate on the outdoor scene and include only sug-



"Rural Portrait"



gestions of the cot on the left and the wooden bench on the right.

Inevitably, there will be sunset pictures Two examples that appear to have "come out" with fair success are "Sunset" and "Place's Pond." The former was shot on the way home from a short excursion. It seemed to deserve photographic attention because of the arrangement and shapes of the clouds and the interesting foreground which, of course, had to be shaded somewhat in printing to allow the greater printing exposure required for the clouds.
"Place's Pond" was one of a series of shots during a sunset. The quality of the water and the delicacy of the sky made a shot imperative.

"Barn Texture" is an example of the type



"Sunset"

of shot that may interest both the pictorial-ist and the antiquarian. This also might be part of a series showing different parts of the barn, exterior as well, possibly, as the interior. The lighting has to be watched carefully, of course, in order that texture may be revealed in the most eloquent way. In printing your vacation pictures, make a special effort to concentrate on a few negatives each acesion rather than attempt to work through the night and try, willy-nilly, to finish up the whole batch all at





"Place's Pond"

once. If you print only a few, you will know that your best work went into them because you will not be tired; if you print many, those towards the end of a weary evening are bound to suffer in quality. When you are through with the nega-

tives, return them immediately to their enclosures which should, of course, be provided when the negative strips are rem from the drying clips and cut up for filing It is so easy, when many negatives are being printed, to let them lie around after an eve ning's work, to gather dust and possibly suffer accidental nicks and scratches

Study your vacation negatives and see where this or that one may have been improved or why this one failed and that one is absolutely hopeless. You will learn much from such careful study that will help yo not only during vacation next time but all through the other seasons of the year.

CLEANING LENSES

PERIODIC cleaning of the camera lens A PERIODIC cleaning of the camera lens should be one of your regular hobby duties. Carefully remove the lens from the camera and brush all surfaces with a camel's hair brush to remove grit and dirt. Wipe the glass with a sponge moistened in spirit. Make sure the sponge is absolutely clean and free of dirt. Finally, polish the surfaces with chamois. Or breathe on the surface of the glass and polish gently with an old, soft, and well-washed cambric or liuen handkerchief.

LIGHTNING SPECIALIST

A FOUR-FOOT lighting rod erected on the tower of New York's Empire State Building provides Bill Eason, General Elec-Building provides Bill Eason, Ochean Elec-tric engineer, with unusual picture material of scientific value, according to a story in The New Yorker. Mr. Eason's exclusive job ane New Yorker. Mr. Eason's exclusive job during the thunder-shower season, May 15 to October 1, is to come down to New York, watch for lightning and take pictures of the bolts as they strike the Empire State. The pictures plus the data are relayed to the home office.

The equipment includes three high-speed cameras in a room on the 39th floor of the building at 500 Fifth Avenue, at Forty-

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second Street; two oscillographs for recording the duration and intensity of lightning strokes, in the Empire State tower; and a fourth camera on the roof of a building at Eighth Avenue and Thirty-fourth Street, which gete the lightning "in profile." The latter camera is operated by remote control from the Fifth Avenue office.

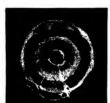
When one of his storm tipaters rings Mr. Eason to the phone, the routine is for Mrs. Eason to taxi from their apartment at 10 Park Avenue to get the cameras ready at 500 Fifth Avenue, while Mr. Eason hurries to the Empire Tower to start the oscillographs, after which he taxis to the Fifth towards after which he taxis to the Fifth total darkness and a time clock is punched to record the instant a picture is taken.

As he works, Mr. Eason talks into a microphone attached to his lapel, a record of his comments being engraved in wax, which Mrs. Eason transcribes the next day for the home office.

The Empire State has been struck by lightning 92 times in the last four years, but no one is ever hurt. Some of the strokes have exceeded 22,000 amperes and have lasted more than a second. It takes about six-tenths of an ampere to light an ordinary 60-watt electric-light bulb.

GLASS PICTURES WITHOUT NEGATIVES

IN a recent letter, E. L. Hettinger, of Reading, Pennsylvania, writee ue about his experiences in the making of prints by enlargement in his apecial field of technical glass etudies, and sends us a beautiful



Without a negative

example of one of the prints he has made. "The matter of making chalgements without negatives," Mr. Hettinger writes, "has been an old stunt employed many times him yofity-five years" of experience. There were times when we would take a piece of lace, or a piece of geometric chipped glass, and place it in the enlarger on a to make a border for some of our negatives. Naturally, this all occurred in the old days when things had to be fancy so as to be attractive. Later on, this experience helped me in my work on heat-treated glass. The man problem was to try to get some field about

the harmonic vibration point of glass.
"To break thousands of pieces of glass and make negatives, and then enlarge them was far from eatisfactory. Under these circumstances, I tried the old stunt of using the glass in the enlarger without making a negative. I found that little if anything

was lost in the print. In the illustration (reproduced here), a steel pellet hit the center of a prece of glass as shown by the inner errele. There was a vibratory motion, and then the energy dissipated from these concentric rings, and showed a fracture which again reverted back to the ring vibrations.

Without trying this experiment, you would hardly know how much was lost in making a negative and then enlarging it. For this reason, I have adopted this method of making enlargements without making negatives, because it saves a lot of time, and one does not lose any of the minute details that are required for studying the subject."

JUST A DETAIL

THERE is a story going the rounds con-cerning the folly of being didactic among one's peers. It seems that a member of a camera club requested a fellow member to develop a dozen negatives for him. Presumably wishing to make sure that no mistake would be made in the processing, he gave complete instructions including the wholly unnecessary one of closing the darkroom door before beginning operations. All these instructions, to the very letter, were set down in writing, and were followed without change. However, one very important step was omitted there was nothing to the effect that the white darkroom light should be turned off before operations were begun. The darkroom worker mischievously went right ahead with all the other instructions, including the removal of the film from ite covering in the ruinous light. Of course, the films were hopeless from the start, but he

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develop these for me?"

A SPECIAL effect, full of warmth and glow, is obtained in portrait lighting by having the subject partly illuminated from below, as in the illustration, "Mary Ellen." This type of lighting is usually called "dramatic" but when so employed it

developed, fixed and dried them, carefully

wrapped them up with interleaving between the negatives and handed the finished work,

very solemnly and innocently, to the owner. The latter stood aghast at the 12 black nega-

tives but took the incident ln good grace when his written instructions, with the fatal

omission, was shown to him. Luckily, the pictures could be taken over again without

trouble, and were. The next day the didactic member again asked the same favor, but this time he simply said: "Will you please



"Mary Ellen"

ardinarily constitutes the main and only light used. However, a softer effect is obtained by having the light come from above, back of the subject and reflected from below by a reflecting screen so placed as to give the effect sought. This was the procedure in the present linguispace.

AWARD FOR

CAMERA HEADLINER

NOR the best foreign newarcel of the year, A. T. Hull, Jr., of Pathe, says an announcement from the makers of the Lcica, was awarded the plaque of the National Headliners Club at a dinner held recently in Atlantic City. The film for which he was given the saward aboved the terrible holocause of the bombing of Canton. Like many of the cameramen covering the hostilities in China, Hull was never without his Leica, and he continually used it for making atilla, many of which have appeared in Life and other national publications.

SPOTTING KINKS

D LACK lines and black spots on prints, caused by transparent lines and holes in the negative, are usually more difficult to remove than spotting out light defects. One effective way to remove both lines and spots

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RULES of the Contest

- e i The groups will be judged independ-ently on the bests of pictorial appeal and technical excellence. The decision of the judges will be final. In case of a tie for any prize, duplicate prizes will be awarded to the tying contentants.
- e s. Prints must not be smaller than 6 by 7 or lerger than 11 by 14 Prints need not be mounted, but may be at the contestant's option
- 3. Photographs must be packed properly to protect them during transportation
- 4. Non-winning entries will be returned only if sufficient postage is included when the prints are submitted
- a E. Each entry must have the following date written on the back of the print or mount Name and address of contestant, type of easeers, and film, enlarger and paper used.
- e S. Contestants may submit no more than two prints in each group but may enter eny or all groups
- ? Prints must be in black and white. Color photographs are not eligible
- 8. Prize-winning photographs will become the property of Scientific American, to be used in any manner at the discretion of the publisher
- B Scientific American reserves the right to purchase, at regular rates, any non-winning entry
- e 10. No entries will be considered from professional photographers
- e 11 All entries in this cor test must be in the hands of the judges by December 1, 1839 Results will be announced in our issue deted February 1940
- 12 This contest i. open to all ame photographers who are not in the employ of Scientific American

This Contest Closes Dec. 1, 1939-All Entries Must Then Be in Hands of Judges

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sion 2. Landscapes—including all scenic views, i-ups of parts of landscapes, sessoapes, and so on

Division 3. Action—including all types of photography in which action is the predominating feature.

In each division there will be prises of two Les weiches—"The World's Most Honored Watch" two Pederal Enlargers, as well as five Honorable Mo

THE JUDGES:

McCitifiand Barcley, artist Ivan Dmitri, artist and photopri short Yarnali Richie, commercial photo

is through the use of ink eradicator. This should be applied a little at a time, remo ing the line bit by bit. The black defect cannot be taken out all at once. For removing small black spots, another method is to use a small spotting brush molded to a fine point and tipped with white spotting color.

The effect should be judged only after the color has been allowed to penetrate the paper at the treated point. If the result is color light, and a little gram the the too light, add a little gray after the first application has dried.

RATHING REACH

THIS suggestion is probably a little late for this year, unless you are on your way south, but it will keep until next time. "Stormy Weather Ahead," a low angle shot suggested by the darkening clouds, is a



"Stormy Weather Ahead"

subject that depends for its effect on the clouds, the nature of the lighting, and an exposure favoring the clouds. In this instance, the clouds covered the sun and an stance, the clouds covered the sun and am acrea which was inadequate for the foreground figure, suitably rendered here in practically a silhouette. The shot was made as the subject swung slightly backward from the hips and looked up toward the approaching clouds.

LAST CALL .

THERE is still time to enter the Fourth Annual Scientific American Photog-raphy Contest—but hurry, hurry, hurry: Entries must be in the hands of the judges by December 1. Doll up your best prints so that they look their finest, for one of

so that mey look their meet, for one of them may bring you a valuable prime. Full details of the contest appear on this page. Be sure to read the rules care-fully so that your prints will be eligible.

NARROW FORMATS

A PRINT does not necessarily have to A fall within the category of the regulation 5 by 7, 8 by 10 or any of the standard paper sizes. If the particular picture you have in hand looks better in a fersist which is narrower with relation to its length shari





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the usual ratio, by all means go sheed and print it that way. In the subject illustrating this piece there seemed nothing to do but treat it as you see it reproduced. The grand display of clouds is the principal attraction and their majesty is greatly emphasized by comparison of the towering masses with



"Majesty"

the small boats on the water below. The negative image had to be considerably "trimmed," but the effect and composition were greatly improved as a result.

IDENTIFYING PAPER EMULSION SIDE

CME vockers find difficulty while in the J darkwom in telling the paper resultance side from the unceated side. This is particularly difficult with smooth paper. There are three general ways of telling the coated from the unceated side. First, there is the familiar one of bitting a corner of the paper. The side that siticks to the teeth is the emulsion side. The other tellitale signs are that the emulion side looks more shury than the other and side that it has a tendency to curve inward, concave fashion.

WHAT'S NEW

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So You Want to Take Better Pictures, by A. P. Peck. A friendly, factor-face chat with the camero owner who has his developing and printing done at the photo shops, yet wants to know enough about his camera and it was to enable hum intelligently to utilize it to best advantage. Over 200 pages, dozens of illustrations, \$2.10.

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O. I have had some trouble with light leaking through the bellows of the camera. What is the proper method of testing for light leaks?-W. J. N.

A. One way is to remove the back of the camera, pall a light-proof cloth over the head and the camera and insert into the bellows a small 4-volt lamp in a holder connected to a pocket lamp battery. Examine the bellows folds, joints and corners. If and when the source of the light loak is discovered, repairs may be made by filling the holes with rubber solution thickened with lamp black powder, or the break or breaks may be covered with small pieces of black court plaster.

Q. How can I obtain the letters A. R. P. S. after my name?—B. W.

A. These letters stand for Associate of the Royal Photographic Society (of Great Britain) and are accorded to members of the Society who have achieved distinction in some field of photography. Membership is open to all photographic workers in all parts of the world. The first step towards the acquisition of the coveted letters is to fill out a regulation form and send it to the Secretary of the Society in London, accompanied with evidences of one's work. Periodically each year these applications are voted upon and if you are turned down once, you can apply again at a later time, with better evidences of your work.

Q. Where and how is distilled water obtainable?—M. J. R.

Distilled water may be purchased at the five-and-ten-cent store or at the drug store. Water free of the foreign matter con tained in water obtained from taps may be had by catching rain water in a non-metallic container, such as an enameled pail or crock.

O. I wish to take stereoscopic color transparencies with a 35mm camera. I am acquainted with the Leica equipa sm acquainted with the Loice equip-ment for this purpose, but can you tell me of any other equipment for taking and viewing these pictures?— D. E. D.

A. You probably are aware that stereo pictures can be taken with any camera imply by using a still subject and shifting he position of the camera between the two res a distance of about 2½ inches, two eyes of a human being As for viewing the resulting stereos, any regular stereo viewer accommodating this size transparency will be austable. An article on stereo photography appeared in our Camera Angles department in the November 1938

Q. I have had very little experience Q. I have had very little experience in photography and eannot spend much, but I will soon need an appar-atus for use in plant-breeding work. Can you advise what type I must get for clear anapshots of plants and also photomicrographs of plant cells and the like?—A. L.

A. The least expensive outfits for your A. The least expensive outnits for your purposes are the Argus and the Mercury, for both of which cameras special apparatus is available in these fields. The service departments of both these organizations will be glad to send you helpful data and auggestions

O. What do you think of taking two exposures on a single film without covering half of the lens? Will the pictures be sharp and worth enlarg--L. D. ing?-

A. This is altogether possible and is, in fact, an arrangement in regular use on viewtype cameras. A ground glass focusing-type camera is required and the proper negative masks must be provided so that one half of the film is covered while the other half is being exposed, and vice versa. If the focusing is accurately done there is no reason why both pictures on the same film should not be as sharp as one picture made on the

Q. Can you tell me where I can get

a list of picture agencies? - J. C.

A. Editor & Publisher, the newspapermen's organ, has a complete list of syndi-cates that buy photographa. The list was reprinted some time ago in an isaue of Camera Magazine, Philadelphia, Pennsylvenia.

Q. Is it possible and practical to make sensitized paper for use in making photostatic copies of printed -L. E. W.

A. Most hand sensitized papers do not have sufficient contrast for photostatic work. Rather, we would suggest the use of some such paper as Novaflex or Outline Special.

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1

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

AT long last, someone has actually built and the spectroscope and spectrohelograph (not to be confused with the spectrohelocope) described in "ATM," thard and fourth editions. For some reason thus instrument never has been popular with the crowd. Arnold S. Mountfort, a portrast artist, 2200 Mountain Oak Drve, Hollywood, Calir, is the first maker (Figure 1). "The actual time, mostly in London," Mountont writes. "The recommended water clock driving mechanism (CATM, page 211).

mechanism ('ATM,' page 211) was not a success, as it always went in jerks due to the dark-slide's friction. Regarding the cost, about which you inquire, I cannot now state but, with a fair genius for getting material for nothing, the whole, including the coelostat, should not cost more than \$10 or \$12.

"The most difficult part was cutting and mounting the slits. By fixing the curved one on the end of a long piece of wood pivoted at the other end, I got a good and true edge by rubbing it against a piece of fine Carborundum stone for the male half and reversing them for the female." It was all intensely interesting

"It was all intensely interesting and well worth the trouble. My first photographs were terrible tragedies. The solar spectrum, though clear, was so over-exposed that it came out positive. But if there was nothing to work for it would not be half the fun. I have found no need for the long focusing rods or for a shed, a galvanized cover giving sufficient protection."

Mountfort, at the time he wrote the above, was painting a portrait of R. W. Porter to be contributed to a gallery of astronomers and telescope dosagners of our time, "in order that those who will be working the 200-nch in 1000 years," as Mountfort puts it, "may know something of the pioneers of this development of

IRST big hurdle to jump when undertaking a Schmidt astronomical camera has been the deep curve, otherwise a lot more Schmidts would be made by amateurs. The Lowers used 25 pounds of Carbo and played wet nurse to their granding machine for 96 hours, in 1932, when roughing a deep compared to the control of the control o

Fred Ferson, Biloxi, Mississippi, therefore suggested some months ago that an attempt he made to wangle the Corning Glass Works, Corning, N. Y., makers of Pyrex baby hottles and 200-inch mirrors, unto casting a batch of Schmidt blanks with approximate curve. Approximate Corner, and the control of the competitive
Figure 1: Mountfort and spectroheliograph

Advised, Corning stated that the most economical way for them to make these would be to rough grind the cavity rather than cast it in, as the molds are expensive; also, for some technical reason, to make the radius 36 inches. They found they could supply these at a little more than double the price of ordinary Pyrex disks of the same size.

Before announcing this fact it was thought best, however, to put these disks to actual test, so Corning sent Ferson a dark, 12% inches, 65-inch relatue, and he spit on his hands and went to but with it. Final report: He spent 12 hours and used two pounds of Carbo in despening the curve from 36 inches to 32 inches and truing it. Used convex tool of full diameter, which example the savey as fast as he plass: hence, no concerve mate vars useded. Metal tool also gave shallower pits, smoother surface, he states. In sum, he reported, it is now possible to grind and pollah a primary for an 1/2 Schmidt, bit an 1/3 Wright, by hand, is about the tidale required for a mixture of like

aize but common focal length. For this, we may thank Ferson and Corning.

AST month in this department it was hinted that James G. Baker, of the Harvard College Observatory, had designed a family of flat-field cameras (Figure 2) equivalent in performance to the Schmidt. The following is his description of them:

"Many years ago Schwarzschild set out to find the most useful system of two mirrors possible. He found that, although there

exists a system that is aplanate and anastgamatic on a flat field, it is of no practical use because of the total allhousting of one mirror by another. As a consequence, Schwarzschild renitroduced astigmatism and solved for the parametric equations of a family of aplanats with flat field. The best known member of the family is a system of two concess mirrors, at the concess of the control of the primary. Astigmatism in the system limits the available field of this reflector.

Improvements in the image quality of reflectors were of a minor nature until Schmidt introduced the idea that small deformations in an otherwise weak lens could be most effective in helping to eliminate the image defects of come and spherical aberration. Wright has generalized the original Schmidt camera into an entire family of Schmidt cameras and has shown that astigmatism cannot be eliminated on a flat field by correcting plate and one mirror alone. Wright's work in turn can be generalized to show that astigmatism cannot be eliminated on a flat field, even

when several correcting plates are employed, all separated, so long as the total powers of these correcting plates are of the second order with respect to the

mirror. Three mirrors with aspherical surfaces can be designed to give excellent performable make a surface and the designed to give excellent performable mathematically, but the allibuouting in such a system is hopoless. Thus, only more more possibility remains, and that is a system of one correcting plate and two mirrors. This combination preduces a two-parameter family of telescopes with a surface of the control of the designed of the designed of the designed of the designed of the overecting plate from the primary mirror and the distance of the potential plate of the designed of the property of the control of the designed of the property of the designed of the potential plate of the potential plate of the property of the designed of the potential plate placed immediately before the secondary, the tube length becomes extremely short compared with the focal lengths. For example, one combination produces a tube one sixth the length of the state of the state of the designed performance. For each short tube length all three of the curved optical surfaces are suphesion. The results of the state of the designed and the designed an

spherical mirror surfaces fortunately pos-

aspherical mirror surtaces iortunatesy pos-sess no inflection points.
"If the tube length be of no serious con-sideration, the two-parameter family in-cludes a remarkable one-parameter family, with tube length about % that of the Schmidt of the same focal length, such that the two mirror surfaces depart inappreciably from spherical surfaces. The curve of the correcting plate becomes much more shallow, and is not much deeper than for the Schmidt of same focal length and aper-

The reasons for the existence of the two

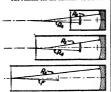


Figure 2: The Schmidt system compared with the two-mirror systems

parameter family can be seen from consideration of the Schmidt and Schwarzschild systems. Then, too, one can deduce the family from the Schmidt system One starts by considering the usual Schmidt camera with an additional plane mirror secondary, untilted, so that the curved focal surface is inverted and near the primary. By keepsurfaces coincident, and by variation of all the curves and separations, the curvature of field can be continuously reduced to the flat field here considered.

"Figure 2 shows an f/3 camera of short ength with an 8 degree unvignetted field, also the corresponding camera of longer tube length and spherical mirror surfaces. Moreover, for comparison purposes a Schmidt camera of exactly the same light gathering power, focal length, and un-vignetted field is shown. The apertures of the two-mirror systems have been adjusted to compensate for the additional ailhouetting and extra surface, absent in the Schmidt.

The advantages that can be pointed out for the two-mirror system are the extremely short tube length possible, with consequent saving in space and material, conveniin loading the plate holder, and the existence of a large, flat, unvignetted field. To give an idea of the importance of the field, if the customary large paraboloidal reflector were converted into this type in the same were converted into this type in the same tube, the number of square degrees photo-graphed per night would equal the number of square degrees photographed by the para-boloidal form per month, the definition at the edge of the useful field being the same, from a very conservative calculation. Fortunately, the two mirrors and plate-holder are close together in what is usually the stiffest part of the tube." In Figure 2 the spherical surfaces, tangent

to the true surfaces of the mirrors in the shortest type, are shown dashed. The mirror curves are exaggerated to twice their true dopths, the correcting plate surface many times, and the feest surface of the Schmidt

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THE BLGINNER'S CORNER

THE experienced telescope user is often THE experienced telescope user is often less inclined to belittle the alt-azimuth type of mounting than is the beginner. With the equatorial type, because one axis is cocked over parallel to that of the Earth, it is necessary to keep moving the telescope tube in only one direction as the Earth axis perpendicular to the Earth's surfacethat is, at some angle to the Earth's axisit is constantly necessary to move the tube in two: for example, over a bit (azimuth) and up a bit (altitude). In practice this isn't nearly so much of a bother as it sounds; while the mounting is simpler to build. The clean, trim alt-azimuth shown was built by J. L. Wagoner of Pitt-burgh, Pa. It has a 6" mirror and a 7" aluminum tube The pillar is a piece of 4" brass tubing and the base and yoke castings are of aluminum



TELESCOPTICS

(Continued from preceding page)

IN the Journal of Scientific Instruments (London), August 1939, H. W. Cox, 47 Upper Green, Mitcham, Surrey, England, an amateur whose first Schmidts were described in the February number, describes in a six-page article his technic of making Schmidts. He sent us an extra copy of the article, which will be lent to those seriously doing Schmidt work who wish to ask for it, provided they will promise to return it promptly so that it may be passed on to others Cox will also send copies to genuine Schmidt workers, if asked. The paper would mean little or nothing to others, as the methods are in no way applieable to work on ordinary telescopes; Schmidts being advanced work.

ONCE a year a "nova" breaks out among telescope makers; verses Most recent poet is the proprietor of the Apex Monu-ment Works (gravestones!), 6815 West 27th Ave., Edgewater (Denver suburb), Colo., who offers the following outburst (novae are due to an overproduction of energy):

The Amsteur Mirror Maker By Anton Bohm

He walks at night, around a keg. on top a disk of glass He pushes forth and pulls it back—another piece For months and months he's kept it up, his patience etill intact One hundred miles he's surely walked around that circular track

He counts the minutes and the strokes, elliptical and streight
He fights against a turned down edge and spheroids
much oblate much oblate aboloid, hyperboloid, ATMA, TB.— words and terms that he can use with ultra-

And puts it on a testing stand to see what he oan see,
And squints along a resur blade and then he abouts
with size:

"At last! I see what seems to be a doughnut fat and round!" But though the shape is these shright, the depth is too profound.

The distance from the inner sone, compered with from the rim, Is much too far eway as yet Se ii appears to him

Again the weary grind begins It surely is no cinch. The surface must be right within one millionth of an inch a ninch is small, and you will promptly a how when he is done with his gigantic table?"

His planois lamp and ranor bisde—they will reveal to him The mirror in its perfect shape, correct from rim to rim

But that is not the only grief-experience he must gain in the not ine only green—experience as unus-gain.

It's finding scratches, siceks and pits that causes him much pain

Dust is a thing that he abhors—he flies into a tantum tantrum

When finding on his polished disk a grain of
Carborupdum

"Oh Wifey! Did you sweep the floor?" he hollers from his shop "If you insist on cleaning up, I'll surely buy a lock." "Indeed you'll not," replies his spouse, "I never yet have seen A place so gory, it's a fright—I'll never get it clean "Rouge over every thing I see It surely is a mess Rouge on my towels, yes on the walls 12's even on my dress"

But all hard tasks some to an end Some night the Poucaut test
WIII throw upon his speculum the shadow he loves beet.

The shape is there—the depth is right, at last the thing is done. He heaves a sigh of deep relief—some people call it fun It fun
And so will you, I dare predict Some day you'll
see (t—but
You nover will, till you've become a Telescoptic Nut.

PORKS, if made by casting from carefully ahaped patterns, may be made very pleasing to the eye but, if not, they somepressing to the eye but, it not, they some times fail to satisfy the telescope maker's feeling for beauty. A kind of fork that can be made with a lathe alone, yet which is pleasing to the eye, is shown in Figure 3. Otto C. Rasmussen, 57 Brunswick Avo., Troy, N. Y., designed this fork, in which he used 1½" steel shafting, a circular plate of ¼" steel and underneath it, two The telescope, a 6" of 50" f. 1 rollers. avoiers. The rerescope, a or of any L. 'a.'
is equipped with a motor drive mention
in triangular baseplate. The latter is
of angle iron with a '4s' steel deck. On



Figure 3: Rasmussen's neat fork

this deck are two double glasses and at the apices three leveling screws with locknuts. The hour circle is of the floating type. The square tube is made of 1/2" x 1/2" x 1/3" angle iron with diagonals of 1/3" x 1/3" strip steel

Rasniussen also made a nocturnal or horometer (Figure 4) for giving sidereal time. The handle is held perpendicularly, Polaris is sighted through the central hole and the straightedge is turned to line up on Beta Ursa Minoris. The pointer then shows sidereal time within about 5 minutes

BOTH "ATM" and "ATMA" recently underwent minor operations when exhaustion of stocks led to reprintings (notehaustion of stocks led to reprintings (note-not new chitunes). Misprints were cor-rected and in "ATM" a few changes made. Old note on p 333 discouraged refractor work, new one encourages it— things have progressed Note on p. 458 was replaced by one telling why photographic lens making is highly advanced work, because numerous novices seem to get the idea that making a photographic lens would be a "simple introduction" to telescoptics! Hallucination.



Figure 4: Rasmussen's horometer



Telegraphic Tape Recorder



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TRADE MARKS AND UNFAIR

COMPETITION
By ORSON D. MUNN

A TRADE MARK is an intangible asset of a business, yet its actual value may grow so large that it becomes the very foundation on which depends the whole structure of the business. Because of this fact, every business man should have available such information on trade marks as will enable him to judge with a fair degree of accuracy the desirability of any mark which he may be considering.

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BBILLS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

Excitizative: A Paorission, edited by J. Anderson Ashum, is a 25-page booklet dealing specifically with the functional aspects of engineering. It should be of great assistance to students who, having decided to follow engineering as a life work, are still at a loss as to what particular work are still at a loss as to what particular ediction. The Mindgam Technic, Gollege of Engineering, University of Michigan.— 25 cents.

TRE SINCOTTA'S BULL, 1940 edition, is a 512-page catalog that illustrates and describes 15,000 items covering guns, accesores, gun tool, ammunition, and all the other gadgets dear to the heart of the gun hobbyist. This one book might almost be called the equivalent of a whole gun library sunce it can serve as a gude to practically everything in which the reader would be interested. Stoeger Arms Corporation, 507 Fifth Avenue at 42nd Street, New York, New York—4100.

Kodakasome, Protocarbet in Color, is a Spage booklet which discusses Kodachrome film, and gives data on its use for
idicolor finling. Exposure technique
both in daylight and artificial light is
treated, and advice on using a photoelectric
exposure meter is included. A number of
the illustration are in color. Estiman
Kodak Company, Rochester, New York—
25 cents.

THE BROWNING PRESELECTOR AND VISUAL FREQUENCY MONITOR IS a single page leaflet, Bulletin 103-A, which describes two instruments of great value to the serrous anateur radio operator. The preselector described has a general coverage of 5 to 185 meters, with electrical band spread, and grea 25 to 70 BB gain on all bands. The visual frequency monitor insures precise frequency measurement on the anateur bands. Browning Laboratories Incorporated, Winchester, Measuchaustics—Craits.

STATISTICS OF RAUMATS OF CLASS I, is a 12 sheet folded bulletin based on the official summaries of the Interestate Commerce Commission from 1926 to 1938. It covert—among other phases—investment and income, fixed charges and dividends, varieties averages, orgulapment and service, Railworp, Bureau of Raulworp Economics, Railworp, Bureau of Raulworp Economics, Washington, D. Crostis as long as limited supply lasts.

AO PROPAZE is a 25-page hooklet which gives a comprehensive picture of the world's oldest and largest optical institution and of the people who work for it. Well-liburated, the booklet was created by American Optical Company for distribution to prospective employees, company visitors, editors. Although the booklet can be read in a few minutes, the reader will nevertheless get minutes, the reader will nevertheless get

as scourse idea of the condition behindful optical concerns and its work-way said, this as understanding of the intrinsate technical problems involved in the insulanteurier of optical equipment of all kinds. The issolder can be considered a valuable contribution to the art of establishing corollal relationships between industry and the public and as such may well be worth studying. American Confession, Company, Scathfridge, Mean.

LETTZ BOOKLET No. 7838 describes the Lettz Gnome II home projector for two by two-inch slides and gives complete information on the projector and accessories. E. Lettz, Inc., 730 Fifth Avenue, New York, N. Y.—Gratie.

SOME CEASMIC MANUFACTURING DEVELOP-MANTS OF THE WESTERE ELECTRIC COM-PANY, by A. G. Johnson and L. I. Shaw, is a 25-page illustrated report which gives a general picture of the development work in implyed in the introduction of manufacturing processes for various ceramics as used in telephone apparatus. The work reported here should be of interest to many other mountaria fields. Bell Telephone Laboratones, 451 Feu Sireet, New York City— Lunted free daturbution.

BLASTING DYCLESS WITH EXPLOSUES in a \$\partial \text{Partial Partial
Allist-Cratamers Texnore Davies and Lo-Manytenance Morons is a 28-page illutrated catalog that shows various types of industrial drives and gives data on how a drive should be selected for a particular purpose. It also lists various types of elotric motors which are particularly adaptable to varying operating conditions. Allis-Chalmers, Mikusukee, Wisconsin.—Gratis.

EARLY FIRE-MAKING METHODS AND DEVCES, by Warren N. Watson, B.S., A.M., is an interesting book of 'I' pages plus an index which gives a running story of the whole history of fire-making from the most primatic implements of early man and more modern but uncivilized races down to the present day match. Historical and described are fire drills of races down to the present day match. Historical and described are fire drills of the second of the Farren N. Fatton, Edifyst, Virginia— \$150 cloth, \$1.00 paper.

KORAK PILMS in a 56-page booklet on Kodak roll films, filmpsedes, ministures and shysic films. Photographic characteristics of the films, such as speed, contrast, and the lifts, are desembed, and the sensimentic terms are explained. Of expected value in the "Specifications" section, which provides full information as so the photographic said physical disconsistentics, the west and gravcesting of each film. Examon Robile Comp. pays, Rocketter, New York—15 comm.

LEGAL HIGH-LIGHTS

Patent, Trade Mark, and Related Legal Proceedings That May Have a Direct Effect on Your Business

By ORSON D. MUNN, Litt.B., L.L.B., Sc.D.

New York Bar

UNDRAMATIC

A SET of rules is not a dramatic theme er the copyright laws. This principle is illustrated by a suit for copyright infringement, brought by the author of a book relating to sales arguments, against a prominent automobile manufacturer. It was charged by the author that the copyright on his book was infringed by a moving nicture used by the automobile manufacturer for demonstrating proper sales tech-nique to its salesmen. The portion of the book which was alleged to be infringed contained a list of six principles or rules of persuasion to be followed in presenting a sales argument. The accused moving picture film depicted three salesmen, two of whom expounded and demonstrated faulty sales arguments. The third salesman expounded and illustrated the proper sales approach and correct sales arguments. In the course of his portrayal the salesman listed certain rules or principles to be followed in presenting a sales argument and the rules thus expounded in the moving picture were similar both in content and in sequence to the six rules listed in the In illustrating the proper sales approach the third salesman carried out or followed the rules which he expounded It was contended by the author of the book that because of the listing of the rules or principles of salesmanship as set forth above and because of their portrayal in the manner described, the moving picture constituted a dramatization of the book and accordingly was an infringement of the copyright thereon.

The Court rejected this contention, point-

ing out first of all that "a set of rules is not a dramatic theme" and that accordingly the moving picture could not be con-sidered a dramatization of the book.

SELLER BEWARE

THE seller of a patent should beware that he does not infringe it because in a suit for infringement of the patent he cannot defend on the grounds that the patent is invalid. In a recent suit for patent inment the inventor of a box for paper fringement the inventor of a box for paper rolls had been an officer of the plaintiff forporation and while in its employ had assigned his patent to the corporation. Subsequently, he severed his connection with the plaintiff corporation and organ-ised the defendant corporation for the purpose of manufacturing and selling boxes for paper rolls. Thereafter the plaintiff pr paper rous. Increater the planting organization sued both the inventor and the defendant corporation, charging patent in-ringement and one of the defenses raised as that the patent was invalid. The Court ruled that the defense of invalidity could not be raised because of the previous relationship between the inventor and the plaintiff corporation and because of the intimate connection between the inventor and the defendant corporation. This suit not only expresses the established principle that the assignor of a patent cannot subsequently question the validity of the patent in a suit brought by the assignee but also carries it one step further and holds that a corporation organized and controlled by the assignor cannot question the validity of the petent.

LACQUER

A PATENT on lacquer consisting of a combination of nitrocellulose and a particular synthetic resin was held valid and infringed in a recent suit for patent infringement which illustrates that the substitution of one ingredient for another may amount to invention. The particular synthetic resin which was mixed with the nstrocellulose was described in the patent as a solution of a glycerol ester of a resin and organic carboxylic acid selected from the group consisting of phthalic, maleic, fumeric, malic, and succinic acids. The Court found that prior to the patent in suit lacquers had been made by mixing nitrocellulose with other types of resin. The Court also found that the particular resin described above was known and had been used for other purposes prior to the patent in suit. It was argued by the defendant that the mere substitution of one resin for another did not amount to invention but was within the range of routine laboratory work and represented mere mechanical skill. On the basis of the evidence introduced in the case, however, the Court concluded that the results obtainable by mixing resins with nitrocellulose could not be predicted, that the production of the lacquer covered by the patent in suit resulted from considerable experiment, and that the lacquer was superior to the lacquers of the prior art. As a result the Court held the patent to be valid.

WEATHER STRIPPING

A PATENT for an all-metal weather stripping which is applied to the window without the use of nails, acrews, or other extraneous fastening means was held to be valid and infringed in a recent suit before the federal courts. The patent in suit disclosed a weather stripping formed of a unitary motal clamping portion adapted to clamp to either the sash or the frame and a resilient motal weather closing strip stateched to the clamparature. The defendant manufacture stripping having a metal clamping portion and a resilient weather closing strip. How ever, the defendant's weather stripping differed from the weather stripping shown in the patent in several respects and it was contended by the defendant that because of these differences his stripping did not infringe the patent. Thus, in the stripping wn in the patent the clamp was fo with an arcuste hooked portion which was not embodied in the defendant's structure. The Court found that plaintiff's weather stripping was new and represented a substantial advance in the art. As a result it concluded that the differences referred to by the defendant were not important and did not avoid infringment.

OUTSMARTED

A RECENT case in the New York State Supreme Court involved a rather novel application of the so-called Fair Trade Act. The Fair Trade Act which has been passed in substantially the same form in most of the states of the Union permits a manufacturer to enter into contracts with his customers, fixing the retail prices at which they may sell commodities bearing his trade mark, name, or brand and provides that knowingly selling commodities beneath the price thus fixed constitutes unfair com-

In the case in question a silk manufacturer ntered into a contract with a dress mar facturer confining the sale of silk bearing the trade mark "Pussy Willow" in the cutting trade to the dress manufacturer who in turn agreed that the retail price of the dresses made from the "Pussy Willow" fabric should not be less than \$12.95. A prominent New York department store attempted to purchase dresses made from the "Pussy Willow" fabric from the dress manufacturer but since the department store would not agree to refrain from selling the dresses for less than \$12.95 each, the dress manufacturer refused to sell the dresses to the department store. Thereafter, the department store obtained dresses from another and unauthorized source hut which were nevertheless manufactured from genuine "Pussy Willow" fabric and they proceeded to sell the dresses for less than \$12.95 each. The silk and dress manufacturers then sought to obtain an injunction against the department store on the grounds that the sale of the dresses for less than \$12.95 each was in violation of the Fair Trade Act and constituted unfair competi-

The Court refused to grant the injunction, pointing out that the dress was manufactured by some other source and was not a product of the dress manufacturer nor did it bear his trade mark, name, or brand-The Court also pointed out that, while the allk was undoubtedly the product of the silk manufacturer, the dress did not constitute a "commodity" produced or owned by the silk manufacturer. The Court, conclud-ing that every act of "outsmarting" does not constitute unfair competition, made the following statement:

"Obviously, the defendant outsmarted the plaintiffs. But the law does not essay to reach every case of outsmarting; nor does every case of outsmarting constitute unfair competition. I recognize the plaintiff's embarrassment and possible loss. But I am unable to perceive that the law here invoked affords them relief."

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